

# 9.3 Exercise Set

FOR EXTRA HELP



**Concept Reinforcement** In each of Exercises 1–8, match the expression or equation with an equivalent expression or equation from the column on the right.

- |                        |                    |
|------------------------|--------------------|
| 1. (g) $\log_5 25$     | a) 1               |
| 2. (d) $2^5 = x$       | b) $x$             |
| 3. (a) $\log_5 5$      | c) $x^5 = 27$      |
| 4. (h) $\log_2 1$      | d) $\log_2 x = 5$  |
| 5. (b) $\log_5 5^x$    | e) $\log_2 5 = x$  |
| 6. (c) $\log_x 27 = 5$ | f) $\log_x 5 = -2$ |
| 7. (e) $5 = 2^x$       | g) 2               |
| 8. (f) $x^{-2} = 5$    | h) 0               |

Simplify.

- |                                     |                                  |
|-------------------------------------|----------------------------------|
| 9. $\log_{10} 1000$ 3               | 10. $\log_{10} 100$ 2            |
| 11. $\log_2 16$ 4                   | 12. $\log_2 8$ 3                 |
| 13. $\log_3 81$ 4                   | 14. $\log_3 27$ 3                |
| 15. $\log_4 \frac{1}{16}$ -2        | 16. $\log_4 \frac{1}{4}$ -1      |
| 17. $\log_7 \frac{1}{7}$ -1         | 18. $\log_7 \frac{1}{49}$ -2     |
| 19. $\log_5 625$ 4                  | 20. $\log_5 125$ 3               |
| 21. $\log_8 8$ 1                    | 22. $\log_7 1$ 0                 |
| 23. $\log_8 1$ 0                    | 24. $\log_8 8$ 1                 |
| Aha! 25. $\log_9 9^5$ 5             | 26. $\log_9 9^{10}$ 10           |
| 27. $\log_{10} 0.01$ -2             | 28. $\log_{10} 0.1$ -1           |
| 29. $\log_9 3$ $\frac{1}{2}$        | 30. $\log_{16} 4$ $\frac{1}{2}$  |
| 31. $\log_9 27$ $\frac{3}{2}$       | 32. $\log_{16} 64$ $\frac{3}{2}$ |
| 33. $\log_{1000} 100$ $\frac{2}{3}$ | 34. $\log_{27} 9$ $\frac{2}{3}$  |
| 35. $5^{\log_5 7}$ 7                | 36. $6^{\log_6 13}$ 13           |

Graph by hand.

- |  |  |
|--|--|
| 37. $y = \log_{10} x$ <input type="checkbox"/>     | 38. $y = \log_2 x$ <input type="checkbox"/>        |
| 39. $y = \log_3 x$ <input type="checkbox"/>        | 40. $y = \log_7 x$ <input type="checkbox"/>        |
| 41. $f(x) = \log_6 x$ <input type="checkbox"/>     | 42. $f(x) = \log_4 x$ <input type="checkbox"/>     |
| 43. $f(x) = \log_{2.5} x$ <input type="checkbox"/> | 44. $f(x) = \log_{1/2} x$ <input type="checkbox"/> |

Graph both functions using the same set of axes.

45.  $f(x) = 3^x, f^{-1}(x) = \log_3 x$

46.  $f(x) = 4^x, f^{-1}(x) = \log_4 x$

Use a calculator to find each of the following rounded to four decimal places.

- |                          |                          |
|--------------------------|--------------------------|
| 47. $\log 4$ 0.6021      | 48. $\log 5$ 0.6990      |
| 49. $\log 13,400$ 4.1271 | 50. $\log 93,100$ 4.9689 |
| 51. $\log 0.527$ -0.2782 | 52. $\log 0.493$ -0.3072 |

Use a calculator to find each of the following rounded to four decimal places.

- |                           |                               |
|---------------------------|-------------------------------|
| 53. $10^{2.3}$ 199.5262   | 54. $10^{0.173}$ 1.4894       |
| 55. $10^{-2.9523}$ 0.0011 | 56. $10^{4.8982}$ 79,104.2833 |
| 57. $10^{0.0012}$ 1.0028  | 58. $10^{-3.89}$ 0.0001       |

Graph using a graphing calculator.

- |   |  |
|---|--|
| 59. $\log(x + 2)$ <input type="checkbox"/>  | 60. $\log(x - 5)$ <input type="checkbox"/>   |
| 61. $\log(2x) - 3$ <input type="checkbox"/> | 62. $\log(3x) + 2$ <input type="checkbox"/>  |
| 63. $\log(x^2)$ <input type="checkbox"/>    | 64. $\log(x^2 + 1)$ <input type="checkbox"/> |

Rewrite each of the following as an equivalent exponential equation. Do not solve.

- |                                  |                                  |
|----------------------------------|----------------------------------|
| 65. $x = \log_{10} 8$ $10^x = 8$ | 66. $h = \log_7 10$ $7^h = 10$   |
| 67. $\log_9 9 = 1$ $9^1 = 9$     | 68. $\log_6 6 = 1$ $6^1 = 6$     |
| 69. $\log_{10} 0.1 = -1$         | 70. $\log_{10} 0.01 = -2$        |
| 71. $\log_{10} 7 = 0.845$        | 72. $\log_{10} 3 = 0.4771$       |
| 73. $\log_c m = 8$ $c^8 = m$     | 74. $\log_b n = 23$ $b^{23} = n$ |
| 75. $\log_t Q = r$ $t^r = Q$     | 76. $\log_m P = a$ $m^a = P$     |
| 77. $\log_e 0.25 = -1.3863$      | 78. $\log_e 0.989 = -0.0111$     |
| 79. $\log_r T = -x$ $r^{-x} = T$ | 80. $\log_c M = -w$              |

Rewrite each of the following as an equivalent logarithmic equation. Do not solve.

- |  |  |
|--|--|
| 81. $10^2 = 100$ $2 = \log_{10} 100$                       | 82. $10^4 = 10,000$                        |
| 83. $4^{-5} = \frac{1}{1024}$ $-5 = \log_4 \frac{1}{1024}$ | 84. $5^{-3} = \frac{1}{125}$               |
| 85. $16^{3/4} = 8$ $\frac{3}{4} = \log_{16} 8$             | 86. $8^{1/3} = 2$ $\frac{1}{3} = \log_8 2$ |
| 87. $10^{0.4771} = 3$                                      | 88. $10^{0.3010} = 2$                      |

89.  $z^m = 6 \quad m = \log_z 6$

90.  $m^n = r \quad n = \log_m r$

91.  $p^m = V \quad m = \log_p V$

92.  $Q^t = x \quad t = \log_Q x$

93.  $e^3 = 20.0855$   
 $3 = \log_e 20.0855$

94.  $e^2 = 7.3891$   
 $2 = \log_e 7.3891$

95.  $e^{-4} = 0.0183$   
 $-4 = \log_e 0.0183$

96.  $e^{-2} = 0.1353$   
 $-2 = \log_e 0.1353$

Solve.

97.  $\log_3 x = 2 \quad 9$

98.  $\log_4 x = 3 \quad 64$

99.  $\log_5 125 = x \quad 3$

100.  $\log_4 64 = x \quad 3$

101.  $\log_x 16 = 4 \quad 2$

102.  $\log_x 81 = 2 \quad 9$

103.  $\log_x 7 = 1 \quad 7$

104.  $\log_x 8 = 1 \quad 8$

105.  $\log_x 9 = \frac{1}{2} \quad 81$

106.  $\log_x 11 = \frac{1}{2} \quad 121$

107.  $\log_3 x = -2 \quad \frac{1}{9}$

108.  $\log_2 x = -1 \quad \frac{1}{2}$

109.  $\log_{32} x = \frac{2}{5} \quad 4$

110.  $\log_8 x = \frac{2}{3} \quad 4$

**TW** 111. Explain why we say that “a logarithm is an exponent.”

**TW** 112. Is it easier to find  $x$  given  $x = \log_9 \frac{1}{3}$  or given  $9^x = \frac{1}{3}$ ? Explain your reasoning.

### SKILL REVIEW

To prepare for Section 9.4, review rules for working with exponents (Section 1.4).

Simplify. [1.4]

113.  $a^{12} \cdot a^6 \quad a^{18}$

114.  $x^4(x^5) \quad x^9$

115.  $\frac{x^{12}}{x^4} \quad x^8$

116.  $\frac{a^{15}}{a^3} \quad a^{12}$

117.  $(y^3)^5 \quad y^{15}$

118.  $(n^{15})^2 \quad n^{30}$

119.  $x^2 \cdot x^3 \quad x^5$

120.  $(x^2)^3 \quad x^6$

### SYNTHESIS

**TW** 121. Would a manufacturer be pleased or unhappy if sales of a product grew logarithmically? Why?

**TW** 122. Explain why the number  $\log_{10} 70$  must be between 1 and 2.

123. Graph both equations using the same set of axes:

$$y = \left(\frac{3}{2}\right)^x, \quad y = \log_{3/2} x.$$

Graph by hand.

124.  $y = \log_2(x - 1)$

125.  $y = \log_3|x + 1|$

Solve.

126.  $|\log_3 x| = 2 \quad \frac{1}{9}, 9$

127.  $\log_4(3x - 2) = 2 \quad 6$

128.  $\log_8(2x + 1) = -1 \quad -\frac{7}{16}$

129.  $\log_{10}(x^2 + 21x) = 2 \quad -25, 4$

Simplify.

130.  $\log_{1/4} \frac{1}{64} \quad 3$

131.  $\log_{1/5} 25 \quad -2$

132.  $\log_{81} 3 \cdot \log_3 81 \quad 1$

133.  $\log_{10}(\log_4(\log_3 81)) \quad 0$

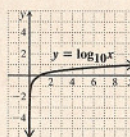
134.  $\log_2(\log_2(\log_4 256)) \quad 1$

135. Show that  $b^x = b^y$  is *not* equivalent to  $x = y$  for  $b = 0$  or  $b = 1$ .

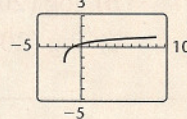
**TW** 136. If  $\log_b a = x$ , does it follow that  $\log_a b = 1/x$ ? Why or why not?

### Try Exercise Answers: Section 9.3

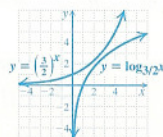
9. 3 35. 7 37.

59.  $y = \log(x + 2)$ 65.  $10^x = 8$  81.  $2 = \log_{10} 100$ 

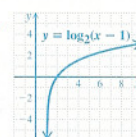
97. 9 99. 3



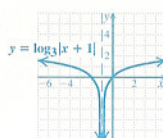
123.



124.



125.



135. Let  $b = 0$ , and suppose that  $x = 1$  and  $y = 2$ . Then  $0^1 = 0^2$ , but  $1 \neq 2$ . Then let  $b = 1$ , and suppose that  $x = 1$  and  $y = 2$ . Then  $1^1 = 1^2$ , but  $1 \neq 2$ .