



Lesson Check

Do you know HOW?

Solve each equation.

- $3^x = 9$
- $2^{y+1} = 25$
- $\log 4x = 2$
- $\log x - \log 2 = 3$

Do you UNDERSTAND?

- Error Analysis** Describe and correct the error made in solving the equation.
- Reasoning** Is it possible for an exponential equation to have no solutions? If so, give an example. If not, explain why.

$$\begin{aligned} \log_2 x &= 2 \log_3 9 \\ \log_2 x &= \log_3 9^2 \\ x &= 9^2 \\ x &= 81 \end{aligned}$$



Practice and Problem-Solving Exercises



Practice

Solve each equation.

- | | | | |
|---------------------|----------------------|------------------------|------------------------------|
| 7. $2^x = 8$ | 8. $3^{2x} = 27$ | 9. $4^{3x} = 64$ | 10. $5^{3x} = \frac{1}{125}$ |
| 11. $2^{5x+1} = 32$ | 12. $3^{-2x+2} = 81$ | 13. $2^{3x} = 4^{x+1}$ | 14. $3^{x+2} = 27^{2x}$ |

← See Problem 1.

Solve each equation. Round to the nearest ten-thousandth.

Check your answers.

- | | | | |
|-------------------|---------------------|-----------------------|---------------------|
| 15. $2^x = 3$ | 16. $4^x = 19$ | 17. $8 + 10^x = 1008$ | 18. $5 - 3^x = -40$ |
| 19. $9^{2y} = 66$ | 20. $12^{y-2} = 20$ | 21. $25^{2x+1} = 144$ | 22. $2^{3x-4} = 5$ |

← See Problem 2.



Graphing Calculator Solve by graphing. Round to the nearest ten-thousandth.

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|--------------------|--------------------|------------------|-------------------|
| 23. $4^{7x} = 250$ | 24. $5^{3x} = 500$ | 25. $6^x = 4565$ | 26. $1.5^x = 356$ |
|--------------------|--------------------|------------------|-------------------|

← See Problem 3.

Use a table to solve each equation. Round to the nearest hundredth.

- | | | | |
|---------------------|--------------------|-------------------|-------------------|
| 27. $2^{x+3} = 512$ | 28. $3^{x-1} = 72$ | 29. $6^{2x} = 10$ | 30. $5^{2x} = 56$ |
|---------------------|--------------------|-------------------|-------------------|

31. The equation $y = 6.72(1.014)^x$ models the world population y , in billions of people, x years after the year 2000. Find the year in which the world population is about 8 billion.

← See Problem 4.

Solve each equation. Check your answers.

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|------------------------|----------------------|-------------------------|------------------------|
| 32. $\log 2x = -1$ | 33. $2 \log x = -1$ | 34. $\log(3x + 1) = 2$ | 35. $\log x + 4 = 8$ |
| 36. $\log 6x - 3 = -4$ | 37. $3 \log x = 1.5$ | 38. $2 \log(x + 1) = 5$ | 39. $\log(5 - 2x) = 0$ |

← See Problem 5.

Solve each equation.

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|----------------------------|--|--------------------------------------|
| 40. $\log x - \log 3 = 8$ | 41. $\log 2x + \log x = 11$ | 42. $2 \log x + \log 4 = 2$ |
| 43. $\log 5 - \log 2x = 1$ | 44. $3 \log x - \log 6 + \log 2.4 = 9$ | 45. $\log(7x + 1) = \log(x - 2) + 1$ |

← See Problem 6.

- 46. Think About a Plan** An earthquake of magnitude 9.1 occurred in 2004 in the Indian Ocean near Indonesia. It was about 74,900 times as strong as the greatest earthquake ever to hit Texas. Find the magnitude of the Texas earthquake. (Remember that an increase of 1.0 on the Richter scale means an earthquake is 30 times stronger.)
- Can you write an exponential or logarithmic equation?
 - How does the solution of your equation help you find the magnitude?
- 47.** Consider the equation $2^{\frac{x}{3}} = 80$.
- Solve the equation by taking the logarithm base 10 of each side.
 - Solve the equation by taking the logarithm base 2 of each side.
 - Writing** Compare your result in parts (a) and (b). What are the advantages of each method? Explain.
- 48. Seismology** An earthquake of magnitude 7.7 occurred in 2001 in Gujarat, India. It was about 4900 times as strong as the greatest earthquake ever to hit Pennsylvania. What is the magnitude of the Pennsylvania earthquake? (*Hint:* Refer to the Richter scale on page 453.)
- 49.** As a town gets smaller, the population of its high school decreases by 6% each year. The senior class has 160 students now. In how many years will it have about 100 students? Write an equation. Then solve the equation without graphing.

Mental Math Solve each equation.

50. $2^x = \frac{1}{2}$ 51. $3^x = 27$ 52. $\log_9 3 = x$ 53. $\log_4 64 = x$
54. $\log_8 2 = x$ 55. $10^x = \frac{1}{100}$ 56. $\log_7 343 = x$ 57. $25^x = \frac{1}{5}$

- 58. Demography** The table below lists the states with the highest and with the lowest population growth rates. Determine in how many years each event can occur. Use the model $P = P_0(1 + r)^x$, where P_0 is population from the table, as of July, 2007; x is the number of years after July, 2007, P is the projected population and r is the growth rate.
- Population of Idaho exceeds 2 million.
 - Population of Michigan decreases by 1 million.
 - Population of Nevada doubles.

State	Growth rate (%)	Population (in thousands)	State	Growth rate (%)	Population (in thousands)
1. Nevada	2.93	2,565	46. New York	0.08	19,298
2. Arizona	2.81	6,339	47. Vermont	0.08	621
3. Utah	2.55	2,645	48. Ohio	0.03	11,467
4. Idaho	2.43	1,499	49. Michigan	-0.30	10,072
5. Georgia	2.17	9,545	50. Rhode Island	-0.36	1,058

Source: U.S. Census Bureau

59. **Open-Ended** Write and solve a logarithmic equation.
60. **Reasoning** The graphs of $y = 2^{3x}$ and $y = 3^{x+1}$ intersect at approximately (1.1201, 10.2692). What is the solution of $2^{3x} = 3^{x+1}$?
61. **Reasoning** If $\log 12^{0.5x} = \log 143.6$, then $12^{0.5x} = \underline{\quad}$.

Acoustics In Exercises 62–63, the loudness measured in decibels (dB) is defined by $\text{loudness} = 10 \log \frac{I}{I_0}$, where I is the intensity and $I_0 = 10^{-12} \text{ W/m}^2$.

62. The human threshold for pain is 120 dB. Instant perforation of the eardrum occurs at 160 dB.
- Find the intensity of each sound.
 - How many times as intense is the noise that will perforate an eardrum as the noise that causes pain?
63. The noise level inside a convertible driving along the freeway with its top up is 70 dB. With the top down, the noise level is 95 dB.
- Find the intensity of the sound with the top up and with the top down.
 - By what percent does leaving the top up reduce the intensity of the sound?

Solve each equation. If necessary, round to the nearest ten-thousandth.

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|-----------------------------------|---------------------------------------|
| 64. $8^x = 444$ | 65. $\frac{1}{2} \log x + \log 4 = 2$ |
| 66. $4 \log_3 2 - 2 \log_3 x = 1$ | 67. $\log x^2 = 2$ |
| 68. $9^{2x} = 42$ | 69. $\log_8(2x - 1) = \frac{1}{3}$ |
| 70. $\log(5x - 4) = 3$ | 71. $12^{4-x} = 20$ |
| 72. $5^{3x} = 125$ | 73. $\log 4 + 2 \log x = 6$ |
| 74. $4^{3x} = 77.2$ | 75. $\log_7 3x = 3$ |

Use the properties of exponential and logarithmic functions to solve each system. Check your answers.

76.
$$\begin{cases} y = 2^{x+4} \\ y - 4^{x-1} = 0 \end{cases}$$

77.
$$\begin{cases} 2^{x+y} = 16 \\ 4^{x-y} = 1 \end{cases}$$

78.
$$\begin{cases} \log(2x - y) = 1 \\ \log(x + y) = 3 \log 2 \end{cases}$$



Solve each equation.

79. $\log_7(2x - 3)^2 = 2$

80. $\log_2(x^2 + 2x) = 3$

81. $\frac{3}{2} \log_2 4 - \frac{1}{2} \log_2 x = 3$

82. **Meteorology** In the formula $P = P_0 \left(\frac{1}{2}\right)^{\frac{h}{4795}}$, P is the atmospheric pressure in millimeters of mercury at elevation h meters above sea level. P_0 is the atmospheric pressure at sea level. If P_0 equals 760 mm, at what elevation is the pressure 42 mm?