

EXERCISES

For more practice, see *Extra Practice*.

Practice and Problem Solving

A Practice by Example

Example 1 (page 447)

- State the property or properties used to rewrite each expression.
- $\log 4 + \log 5 = \log 20$
 - $\log_3 32 - \log_3 8 = \log_3 4$
 - $\log z^2 = 2 \log z$
 - $\log_6 \sqrt[y]{x^p} = \frac{p}{n} \log_6 x$
 - $8 \log 2 - 2 \log 8 = \log 4$
 - $\log \sqrt[3]{3x} = \frac{1}{3} \log 3x$
 - $3 \log_4 5 - 3 \log_4 3 = \log_4 \left(\frac{5}{3}\right)^3$
 - $2 \log w + 4 \log z = \log w^2 z^4$
 - $2 \log_2 m - 4 \log_2 n = \log_2 \frac{m^2}{n^4}$
 - $\log_b \frac{1}{8} + 3 \log_b 4 = \log_b 8$

Example 2 (page 447)

Write each logarithmic expression as a single logarithm.

- $\log 7 + \log 2$
- $\log_2 9 - \log_2 3$
- $5 \log 3 + \log 4$
- $\log 8 - 2 \log 6 + \log 3$
- $4 \log m - \log n$
- $\log 5 - k \log 2$
- $\log_6 5 + \log_6 x$
- $\log_7 x + \log_7 y - \log_7 z$

Example 3 (page 447)

Expand each logarithm.

- $\log x^3 y^5$
- $\log_7 22xyz$
- $\log_4 5\sqrt{x}$
- $\log 3m^4 n^{-2}$
- $\log_5 \frac{r}{s}$
- $\log_3 (2x)^2$
- $\log \frac{a^2 b^3}{c^4}$
- $\log \sqrt{\frac{2x}{y}}$
- $\log_3 7(2x - 3)^2$
- $\log \frac{s\sqrt{t}}{t^2}$
- $\log_8 8\sqrt{3a^5}$
- $\log_b \frac{1}{x}$

Example 4 (page 448)

- One brand of ear plugs claims to block the sound of snoring as loud as 22 dB. A second brand claims to block snoring that is eight times as intense. If the claims are true, for how many more decibels is the second brand effective?
- A sound barrier along a highway reduced the intensity of the noise reaching a community by 95%. By how many decibels was the noise reduced?


B Apply Your Skills

Use the properties of logarithms to evaluate each expression.

- $\log_2 4 - \log_2 16$
- $3 \log_2 2 - \log_2 4$
- $\log_3 3 + 5 \log_3 3$
- $\log 1 + \log 100$
- $\log_6 4 + \log_6 9$
- $2 \log_8 4 - \frac{1}{3} \log_8 8$
- $2 \log_3 3 - \log_3 3$
- $\frac{1}{2} \log_5 1 - 2 \log_5 5$
- $\log_9 \frac{1}{3} + 3 \log_9 3$
- Error Analysis** Explain why the expansion below of $\log_4 \sqrt{\frac{t}{s}}$ is incorrect. Then do the expansion correctly.
$$\begin{aligned} \log_4 \sqrt{\frac{t}{s}} &= \frac{1}{2} \log_4 \frac{t}{s} \\ &= \frac{1}{2} \log_4 t - \log_4 s \end{aligned}$$
- Open-Ended** Write $\log 150$ as a sum or difference of two logarithms.

Assume that $\log 4 \approx 0.6021$, $\log 5 \approx 0.6990$, and $\log 6 \approx 0.7782$. Use the properties of logarithms to evaluate each expression. Do not use your calculator.


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|------------------------|-------------------------|---------------------|
| 44. $\log 24$ | 45. $\log 30$ | 46. $\log 16$ |
| 47. $\log 125$ | 48. $\log 1.5$ | 49. $\log 0.8$ |
| 50. $\log \frac{1}{4}$ | 51. $\log \frac{1}{25}$ | 52. $\log 25$ |
| 53. $\log \frac{1}{6}$ | 54. $\log 36$ | 55. $\log \sqrt{5}$ |

-  **56. Noise Control** New components reduce the sound intensity of a certain model of vacuum cleaner from 10^{-4} W/m^2 to $6.31 \times 10^{-6} \text{ W/m}^2$. By how many decibels do these new components reduce the vacuum cleaner's loudness?

- 57. Reasoning** If $\log x = 5$, what is the value of $\frac{1}{x}$?

Write *true* or *false* for each statement. Justify your answer.

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| 58. $\log_2 4 + \log_2 8 = 5$ | 59. $\log_3 \frac{3}{2} = \frac{1}{2} \log_3 3$ |
| 60. $\log_3 8 = 3 \log_3 2$ | 61. $\log_5 16 - \log 2 = \log_5 8$ |
| 62. $\log(x - 2) = \frac{\log x}{\log 2}$ | 63. $\frac{\log_b x}{\log_b y} = \log_b \frac{x}{y}$ |
| 64. $(\log x)^2 = \log x^2$ | 65. $\log_4 7 - \log_4 3 = \log_4 4$ |
| 66. $\log x + \log(x^2 + 2) = \log(x^3 + 2x)$ | 67. $\log_2 3 + \log_3 2 = \log_6 6$ |
| 68. $\log_2 x - 4 \log_2 y = \log_2 \frac{x}{y^4}$ | 69. $\log_b \frac{1}{8} + 3 \log_b 4 = \log_b 8$ |

-  **70. Construction** Suppose you are the supervisor on a road construction job. Your team is blasting rock to make way for a roadbed. One explosion has an intensity of $1.65 \times 10^{-2} \text{ W/m}^2$. What is the loudness of the sound in decibels? (Use $I_0 = 10^{-12} \text{ W/m}^2$.)

- 71. Critical Thinking** Can you expand $\log_3(2x + 1)$? Explain.



- 72. Writing** Explain why $\log(5 \cdot 2) \neq \log 5 \cdot \log 2$.

Write each logarithmic expression as a single logarithm.

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| 73. $\frac{1}{4} \log_3 2 + \frac{1}{4} \log_3 x$ | 74. $\frac{1}{2}(\log_x 4 + \log_x y) - 3 \log_x z$ |
| 75. $2 \log 3 - \frac{1}{2} \log 4 + \frac{1}{2} \log 9$ | 76. $x \log_4 m + \frac{1}{y} \log_4 n - \log_4 p$ |
| 77. $\left(\frac{2 \log_b x}{3} + \frac{3 \log_b y}{4}\right) - 5 \log_b z$ | 78. $\frac{\log z - \log 3}{4} - 5 \frac{\log x}{2}$ |

Expand each logarithm.

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|---|---|---|
| 79. $\log \left(\frac{2\sqrt{x}}{5}\right)^3$ | 80. $\log \frac{m^3}{n^4 p^{-2}}$ | 81. $\log 2 \sqrt{\frac{4r}{s^2}}$ |
| 82. $\log_b \frac{\sqrt{x} \sqrt[3]{y^2}}{\sqrt[5]{z^2}}$ | 83. $\log_4 \frac{\sqrt{x^5 y^7}}{zw^4}$ | 84. $\log \frac{\sqrt{x^2 - 4}}{(x + 3)^2}$ |
| 85. $\log \sqrt{\frac{x\sqrt{2}}{y^2}}$ | 86. $\log_3 \left[(xy)^{\frac{1}{3}} \div z^2\right]^3$ | 87. $\log_7 \frac{\sqrt{r + 9}}{s^2 t^{\frac{1}{3}}}$ |