

Lesson 8.3: Laws of Logarithms

Product Law	$\log_c xy = \log_c x + \log_c y$
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Note: $c > 0, c \neq 1$

Example: $\log_3 27 = \log_3 9 + \log_3 3$

Quotient Law	$\log_c \left(\frac{x}{y}\right) = \log_c x - \log_c y$
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Example: $\log_5 25 = \log_5 125 - \log_5 5$

Power Law	$\log_c (x^r) = r \log_c x$
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Example: $\log_2 64 = 6 \log_2 2$

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Example 1

Use the Laws of Logarithms to Evaluate Expressions

a) $\log_6 8 + \log_6 9 - \log_6 2$

b) $2\log_2 12 - (\log_2 6 + \frac{1}{3}\log_2 27)$

c) $\log_8 \sqrt{80} - \log_8 \sqrt{5}$



Your Turn

d) $\log_3 9\sqrt{3}$

Answer: $\frac{5}{2}$

e) $\log_5 1000 - \log_5 4 - \log_5 2$

Answer: 3

f) $2\log_3 6 - \frac{1}{2}\log_3 64 + \log_3 2$

Answer: 2

★ Change of base formula: $\log_a b = \frac{\log b}{\log a}$

Example: $\log_6 36$

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Example 2

Use the Laws of Logarithms to Expand Expressions

a) $\log_5 \frac{xy}{w}$

b) $\log_7 \sqrt[3]{x}$

c) $\log_6 \frac{1}{x^2}$

d) $\log \frac{x^3}{y\sqrt{z}}$

Questions: p.400-401 #1a-d, 2a-d, 3a-d, 5ab, 7abc, 8abcd, 9abcd

Example 3

Use the Laws of Logarithms to Simplify Expressions

Write each expression as a **single** logarithm in simplest form. State the restrictions on the variable.

a) $2\log_7 x + \log_7 x^3 - \frac{5\log_7 x}{2}$

b) $\log_4(x) - \log_4(x-1)$

c) $\frac{1}{3}\log x + \log y - 3\log z$

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d) $\log_5(2x-2) - \log_5(x^2 + 2x - 3)$

★ Solve a quadratic inequality using a sign diagram

e) $\log_3(x^2 - 4) - \log_5(x^2 - x - 2)$

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Your Turn

f) $4\log_3 x - \frac{1}{2}(\log_3 x + 5\log_3 x)$

Answer: $\log_3 x, x > 0$

g) $\log_2(x^2 - 9) - \log_2(x^2 - x - 6)$

Answer: $\log_2\left(\frac{x+3}{x+2}\right), x < -3 \text{ or } x > 3$

Questions: p.400-401 # 10a, 11ab, 12(abc)