Properties of Logarithms

A logarithm is an exponent.

Exponent Rules

$x^2 \cdot x^5 = x^7$ $\quad x^a \cdot x^b = x^{a+b}$

$\frac{x^9}{x^4} = x^5$ $\quad \frac{x^a}{x^b} = x^{a-b}$

$(x^2y^3)^4 = x^8y^{12}$ $\quad (x^ay^b)^c = x^{a \cdot c}y^{b \cdot c}$

$\left(\frac{x^4}{y^7}\right)^3 = \frac{x^{12}}{y^{21}}$ $\quad \left(\frac{x^a}{y^b}\right)^c = \frac{x^{a \cdot c}}{y^{b \cdot c}}$

$x^{-6} = \frac{1}{x^6}$ $\quad x^{-a} = \frac{1}{x^a}$

or

$\frac{1}{x^{-6}} = x^6$ $\quad \frac{1}{x^{-a}} = x^a$

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Product Property of Logarithms

Exponents

$x^a \cdot x^b = x^{a+b}$

*each base should have its own log.

*the base of each log should be the same as the original.

$$\log a \cdot b = \log a + \log b$$

$\log 4 \cdot 5 = \log 4 + \log 5$

$\log_8 x \cdot y \cdot z = \log_8 x + \log_8 y + \log_8 z$

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Quotient Property of Logarithms

Exponents

$\frac{x^a}{x^b} = x^{a-b}$

* +log → Numerator
* −log → Denominator

$$\log \frac{a}{b} = \log a - \log b$$

$\log \frac{7}{5} = \log 7 - \log 5$

$\log_5 \frac{7x}{3} = \log_5 7 + \log_5 x - \log_5 3$

$\log_3 \frac{11}{2x} = \log_3 11 - \log_3 2 - \log_3 x$

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Power Property of Logarithms

Exponents

$(x^a)^b = x^{a \cdot b}$

Separate the bases before you use the power property.

$$\log b^a = a \log b$$

$\log 2^5 = 5 \log 2$

$\log_4 x^3 y = \log_4 x^3 + \log_4 y$

$= 3 \log_4 x + \log_4 y$

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$\log_5 x^2 y^4 = \log_5 x^2 + \log_5 y^4$

$= 2\log_5 x + 4\log_5 y$

① Simplify Exponents.
② Separate Bases.
③ Power Rule.

$\log_6 \left(\frac{x^3}{y}\right)^4 = \log_6 \frac{x^{12}}{y^4}$

$= 12\log_6 x - 4\log_6 y$

$\log_3 \frac{(x^2 y^3)^5}{a^7} = \log_3 \frac{x^{10} y^{15}}{a^7}$

$= 10\log_3 x + 15\log_3 y - 7\log_3 a$

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Condensing Logarithms

* Where you take multiple logarithms with the same base and condense them into a single logarithm.

$\log a + \log b = \log a \cdot b$

$\log a - \log b = \log \frac{a}{b}$

$a \log b = \log b^a$

$3\log x - 4\log y - 7\log z$

$\log x^3 - \log y^4 - \log z^7$

$\log \frac{x^3}{y^4 z^7}$

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$7\log_5 x + 8\log_5 y = \log_5 x^7 + \log_5 y^8$

$= \boxed{\log_5 x^7 y^8}$

$6\log a - 12\log x = \log a^6 - \log x^{12}$

$= \boxed{\log \frac{a^6}{x^{12}}}$

$3\log a - 2\log x + \frac{1}{2}\log y$ $\quad y^{\frac{1}{2}} = \sqrt{y}$

$\log a^3 - \log x^2 + \log \sqrt{y}$

$\log \frac{a^3\sqrt{y}}{x^2}$

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