

Properties of Logarithms

Quiz tomorrow (no calculator)

HW: Study for quiz, Days 1 - 5, not today's Day 6.

Note Friday night's homework goes with today's notes.

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4.4 Properties of Logarithms

PreCalc
Unit 4 Day 5

Product Property: $\log_b mn = \log_b m + \log_b n$

Quotient Property: $\log_b \frac{m}{n} = \log_b m - \log_b n$

Power Property: $\log_b m^p = p \log_b m$

Root Property: $\log_b \sqrt[n]{p} = \log_b p^{\frac{1}{n}} = \frac{1}{n} \log_b p$

Remember: $\log_e m = \ln m$
 $\log_{10} m = \log m$

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ExpandExpress in terms of sums and differences of logs:

$$1. \ln x^3 \sqrt{y} = \ln x^3 + \ln y^{1/2} \\ = 3 \ln x + \frac{1}{2} \ln y$$

$$2. \log \sqrt[3]{\frac{x^2 y}{z}} = \log \left(\frac{x^2 y}{z} \right)^{1/3} \\ = \frac{1}{3} \log \frac{x^2 y}{z} = \frac{1}{3} \log x^2 y - \frac{1}{3} \log z \\ = \frac{1}{3} \log x^2 + \frac{1}{3} \log y - \frac{1}{3} \log z \\ = \frac{2}{3} \log x + \frac{1}{3} \log y - \frac{1}{3} \log z$$

$$3. \log \left(\frac{a^2}{3b^4} \right)^{1/3} = \log \frac{a^2}{27b^{12}} \\ = \log a^2 - \log 27b^{12} \\ = \log a^2 - (\log 27 + \log b^{12}) \\ = \log a^2 - \log 27 - 12 \log b \\ = 2 \log a - \log 27 - 12 \log b$$

$$4. \ln \left(\frac{xy}{z^3} \right) = \ln x + \ln y - 3 \ln z$$

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Squish

Write as a single log:

$$1. \log (2x+7) + \log (x-1) \\ = \log (2x+7)(x-1) \\ = \log (2x^2+5x-7)$$

$$2. \quad \begin{array}{l} \text{2ln}(x-3) - \ln(x^2-9) \\ = \ln(x-3)^2 - \ln(x^2-9) \\ = \ln \frac{(x-3)^2}{(x^2-9)} = \ln \frac{(x-3)(x-3)}{(x-3)(x+3)} \\ = \ln \left(\frac{x-3}{x+3} \right) \end{array}$$

$$3. \log a + \frac{1}{2}(\log b - \log c) \\ = \log a + \log b^{1/2} - \log c^{1/2} \\ = \log \left(\frac{a \sqrt{b}}{\sqrt{c}} \right) \\ = \log \frac{a \sqrt{b}}{\sqrt{c}}$$

$$4. \quad \begin{array}{l} 2 - \log(10x) \\ \log 100 - \log 10x \\ = \log \frac{100}{10x} = \log \frac{10}{x} \end{array}$$

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5. $2\ln(x-5) + \ln x$

$$= \ln(x-5)^2 + \ln x$$

$$= \ln(x-5)^2 \cdot x$$

$$= \ln x(x^2 - 10x + 25)$$

$$= \ln(x^3 - 10x^2 + 25x)$$

Simplify

6. $\ln e^{5x}$

$$= 5x \cancel{\ln e}$$

$$= 5x$$

$$\ln e = \log_e e = x$$

$$e^x = e$$

$$x = 1$$

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7. Graph $y = \ln x$. Find domain, range and intercepts.

X	.5	1	2	3
Y	-.69	0	.69	1.10

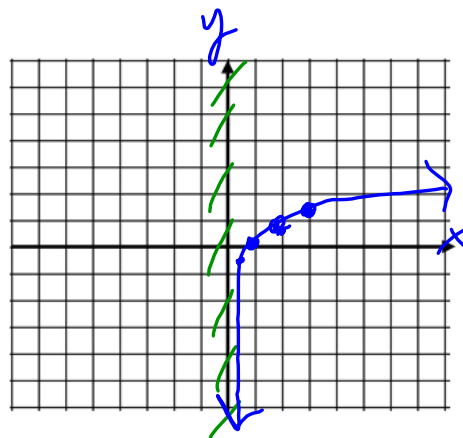
D: $\{x | x > 0\}$

R: $\{y | y \in \mathbb{R}\}$

x-intercept(s): (1, 0)

y-intercept(s): none

VA: @ $x = 0$



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8. Graph $y = \ln(x + 1)$. Find domain, range, and intercepts.

x	-0.5	0	1	2
y	-0.69	0	0.69	1.10

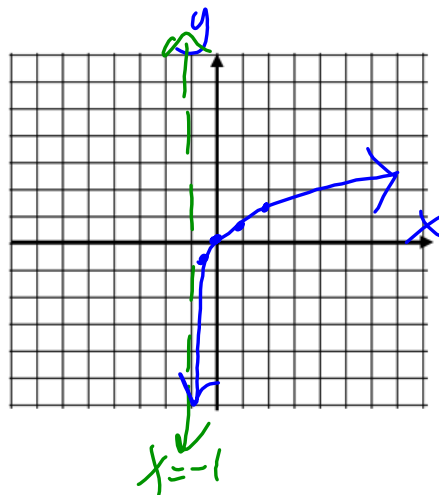
D: $\{x \mid x > -1\}$

R: $\{y \mid y \in \mathbb{R}\}$

x-intercept(s): $(0, 0)$

y-intercept(s): $(0, 0)$

VA: $x = -1$



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9. Name the transformation that takes place from $y = \ln x$ to

a. $y = \ln x + 3$

vert shift
up 3

b. $y = \ln(x + 3)$

horizontal
shift left 3

c. $y = \ln(-x)$

ry-axis

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10. Let $a = \ln x$, $b = \ln y$ and $c = \ln 2$. Find each of the following in terms of $a, b,$ & c :

a. $\ln\left(\frac{x^2y^2}{2}\right)$

$$\begin{aligned} &= \ln(x^2y^2) - \ln 2 \\ &= \ln x^2 + \ln y^2 - \ln 2 \\ &= 2\ln x + 2\ln y - \ln 2 \\ &= 2a + 2b - c \end{aligned}$$

b. $\ln(\sqrt[3]{xy})$

$$\begin{aligned} &= \ln(xy)^{1/3} \\ &= \frac{1}{3} \ln x + \frac{1}{3} \ln y \\ &= \frac{a}{3} + \frac{b}{3} = \frac{a+b}{3} \end{aligned}$$

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