

10.3 Laws of Logs

Warm-Up Wednesday

Evaluate without your calculator

$$1. \quad 3 \log_2 8 \quad 2^? = 8$$

$$3 \cdot 3 = \boxed{9}$$

$$2. \quad \log_3(\log_3(\log_3 27))$$

$$\log_3(\log_3 3) \quad 3^? = 27$$

$$\log_3(1) \quad 3^? = 3$$

$$\boxed{0} \quad 3^? = 1$$

About Me

1. When you meet someone new, what do you want them to know about you in the first 5 minutes?
2. Would you rather break someone else's heart, or have someone break yours?

10.3 Laws of Logs

EQ: How do I expand or condense logarithmic expressions?

Note: All the laws of logarithms come from the laws of exponents.

1. The ^(multiply) Product Law

Recall that for exponents $a^n \cdot a^m = \underline{a^{m+n}}$

So, $\log_a(x \cdot y) = \underline{\log_a x + \log_a y}$

10.3 Laws of Logs

EQ:

How do I expand or condense logarithmic expressions?

^(Division)
2. The Quotient LawRecall that for exponents $\frac{a^n}{a^m} = a^{n-m}$

$$\text{So, } \log_a \left(\frac{x}{y} \right) = \log_a x - \log_a y$$

10.3 Laws of Logs

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3. The Power Law

Recall that for exponents $(a^m)^p = a^{mp}$

So, $\log_a x^p = p \log_a x$



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How do I expand or condense logarithmic expressions?

4. Some Other Properties

$$\log_b b^x = \underline{x}$$

$x \log_b b$

$$b^{\log_b x} = \underline{x}$$

$$\log_b 1 = \underline{0} \quad b^0 = 1$$

$$b^{\log_b x} = y$$

$$\log_b y = \log_b x$$

$$y = x$$

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EQ:

How do I expand or condense logarithmic expressions?

Example 1 - Express the following as multiple logarithms. *(expand)*

a) $\log_a x^2 y^3 z^5$

$$\log_a x^2 + \log_a y^3 + \log_a z^5$$

$$2\log_a x + 3\log_a y + 5\log_a z$$

b) $\log_b \frac{(xy^2)}{z^3}$

$$\log_b(xy^2) - \log_b(z^3)$$

$$\log_b x + \log_b y^2 - \log_b z^3$$

$$\log_b x + 2\log_b y - 3\log_b z$$

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EQ: How do I expand or condense logarithmic expressions?

Example 2 - Express the following as a single logarithm. Simplify if possible.

a) $\frac{2}{3}\log_a x - \frac{1}{2}\log_a y$

$\log_a x^{2/3} - \log_a y^{1/2}$

$\log_a \left(\frac{x^{2/3}}{y^{1/2}} \right)$

b) $\frac{1}{2}\log_a x + 3\log_a y - 2\log_a z$

$\frac{\log_a x^{1/2} + \log_a y^3 - \log_a z^2}{\log_a x^{1/2} y^3 - \log_a z^2}$

$\log_a \left(\frac{x^{1/2} y^3}{z^2} \right)$

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EQ: How do I expand or condense logarithmic expressions?

Example 3 – Evaluate. (number answer)

a) $\log_6 9 + \log_6 16 - \log_6 4$

$$\log_6 \left(\frac{9 \cdot 16}{4} \right)$$

$$\log_6 36$$

$$6^? = 36$$

2

b) $10^{\log 50 + \log 2}$

(base 10)

$$10^{\log(50 \cdot 2)}$$

~~$$10^{\log 100}$$~~

100

c) $9^{\log_3 5}$

$$9 = 3^2$$

$$(3^2)^{\log_3 5}$$

$$3^{2 \log_3 5}$$

~~$$3^{\log_3 5^2}$$~~

25

d) $8^{-\log_2 3}$

$$2^3 = 8$$

$$(2^3)^{-\log_2 3}$$

$$2^{-3 \log_2 3}$$

~~$$2^{\log_2 3^{-3}}$$~~

$$3^{-3}$$

$\frac{1}{27}$

10.3 – Laws of Logarithms

Name: _____

Evaluate

1. $\log_3 6 + \log_3 \frac{3}{2}$

2. $\log_2 5 + \log_2 10 - \log_2 25$

3. $\log_3 36 - \log_3 4$

4. $3 \log_2 8$

5. $7^{\log_7 5 + \log_7 2}$

6. $10^{\log 12 - \log 2}$

7. $2^{\log_2 6 - \log_2 12}$

8. $9^{\log_3 5}$

9. $4^{\log_2 3}$

10. $8^{-\log_2 3}$

11. $\log_3 (\log_3 (\log_3 27))$

12. $\log_2 (\log_2 (\log_2 16))$

13. $\log (\log_2 (\log_3 9))$

14. $(\log_{36} 6)(\log_6 36)$

Express as multiple logs.

15. $\log_a 5x^2y^3z$

16. $\log_b \frac{xy^2}{z^3}$

17. $\log_a \sqrt[4]{\frac{xy}{z^3}}$

18. $\log \frac{\sqrt{xyz}}{z}$

19. $\ln \sqrt{x^4 - 4x}$

20. $\ln \frac{x}{x^2 + 1}$

Express as a single logarithm. Simplify and use radicals where needed.

$$21. \frac{1}{2} \log_2 x + \frac{1}{3} \log_2 y - 2 \log_2 x$$

$$22. \log_3 2x + 3(\log_3 x - \log_3 y)$$

$$23. \ln x^2 - 2 \ln \sqrt{x}$$

$$24. \ln(x^2 - 4) - \ln(x - 2)$$

$$25. \frac{1}{2} \log(x - 1) + \frac{1}{2} \log(x^2 + 2) + \frac{3}{2} \log(x + 4)$$

$$26. 5 \ln x + \ln \sqrt{y} + 2 \ln z - \frac{1}{3} \ln w$$



True or False.

$$27. \frac{\log_a M}{\log_a N} = \log_a M - \log_a N$$

$$28. \log_a 2x = 2 \log_a x$$

$$29. \ln(M + N) = \ln M + \ln N$$

$$30. \ln 2x = \ln 2 + \ln x$$

$$31. \frac{\log_a M}{\log_a N} = \log_a \frac{M}{N}$$

$$32. \ln x^3 = 3 \ln x$$

