# 10.3 Laws of Logs

## Warm-Up Tuesday

1. Evaluate without your calculator

$3\log_2 8$

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

$\log_2 8 = x$

$2^x = 8$

$x = 3$

2. Change $e^{5y} = 12$ into a log equation using ln.

$\log_e 12 = 5y$

$\boxed{\ln 12 = 5y}$

## About Me

1. Would you rather become someone else or stay you?

2. Would you rather hear the good news or the bad news first?

# 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 Product Law

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

**Condensed:**

$\log(AB)$

multiplied INSIDE

**Expanded:**

$\log A + \log B$

add OUTSIDE

# 10.3 Laws of Logs

EQ: How do I expand or condense logarithmic expressions?

## 2. The Quotient Law

Recall that for exponents $\frac{a^n}{a^m} =$ $a^{n-m}$

**Condensed:**

$\log\left(\frac{A}{B}\right)$

divide INSIDE

**Expanded:**

$\log A - \log B$

subtract OUTSIDE

# 10.3 Laws of Logs

EQ: How do I expand or condense logarithmic expressions?

## 3. The Power Law

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

**Condensed:**

$\log(A^B)$

exponent inside

**Expanded:**

$B \log A$

multiply outside (coefficient)

# 10.3 Laws of Logs

EQ: How do I expand or condense logarithmic expressions?

$(a+b)^2 \neq a^2+b^2$

$\log(x+y) \neq \log x + \log y$

LOG DOES NOT DISTRIBUTE

# 10.3 Laws of Logs

EQ: How do I expand or condense logarithmic expressions?

**Condense into one log**

- check for same base
- coefficients → exponents
- Left to Right

$\log_3 12 + \frac{1}{2}\log_3 9 - \log_3 2$

$\log_3 12 + \log_3 9^{1/2} - \log_3 2$

$\sqrt{9} = 3$

$\log_3\left(\frac{12 \cdot 3}{2}\right)$

$\boxed{\log_3 18}$

$\log_3 x - 2\log_3 y + \log_3 z$

$\log_3 x - \log_3 y^2 + \log_3 z$

$\log_3\left(\frac{x}{y^2} \cdot z\right)$

$\boxed{\log_3\left(\frac{xz}{y^2}\right)}$

# 10.3 Laws of Logs

EQ: How do I expand or condense logarithmic expressions?

**Expand into multiple logs**

$$\ln\left(\frac{ab}{\sqrt[3]{c}(d+1)}\right)$$

$$\ln(ab) - \ln\left(\sqrt[3]{c}\cdot(d+1)\right)$$

$$\ln a + \ln b - \left(\ln \sqrt[3]{c} + \ln(d+1)\right)$$

$$c^{1/3}$$

$$\boxed{\ln a + \ln b - \frac{1}{3}\ln c - \ln(d+1)}$$

# 10.3 Laws of Logs

EQ: How do I expand or condense logarithmic expressions?

**Change of base**

$\log_B X = \frac{\log X}{\log B}$ OR $\frac{\ln X}{\ln B}$

$\log_2 5 = \frac{\log 5}{\log 2}$

## Some Other Properties

$x\log_b b =$ $\log_b b^x =$ X

$b^? = b$

$b^{\log_b x} =$ X

$\log_b 1 =$ 0

$b^? = 1$

# 10.3 Laws of Logs

EQ: How do I expand or condense logarithmic expressions?

**Other Logs**

$\cancel{3^{\log_3 7}}$

$\boxed{7}$

$3^{4\log_3 2 - \log_3 2}$

$\log_3 2^4 - \log_3 2$

$\log_3\left(\frac{2^4}{2}\right)$

$\cancel{3^{\log_3 8}}$

$\boxed{8}$

$9^{\log_3 6}$

$3^{2\log_3 6}$

$\cancel{3^{\log_3 6^2}}$

$6^2$

$\boxed{36}$

inside out

$\log_2(\log_3(\log_3 27))$

$3^? = 27$

$3$

$\log_2(\log_3 3)$

$3^? = 3$

$\log_2(1)$

$2^? = 1$

$\boxed{0}$

# 10.3 Laws of Logs

EQ: How do I expand or condense logarithmic expressions?

## Exit Ticket on Classroom!

**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.** (expand)

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

don't forget exit ticket!

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