Name: ______________________ Per: ____

Evaluating Logarithms

Since logarithms are basically exponents written a new way, evaluating or solving them means that you have to answer the question: This base to **what power** (or exponent) will equal the inside?

For example: Evaluate $\log_3 9$.

*The base of 3 to **what power** will equal the 9 inside? The answer is* $\boxed{2,}$ *because* $3^{\boxed{2}} = 9$

1. Evaluate $\log_2 8$.	2. Evaluate $\log_4 16$.	3. Evaluate $\log_3 81$.
4. Evaluate $\log_5 125$.	5. Evaluate $\log_2 32$.	6. Evaluate $\log_7 49$.
7. Evaluate $\log_{12} 144$.	8. Evaluate $\log_7 343$.	9. Evaluate $\log_{10} 10{,}000$.

The rules of logarithms are there to make logarithms easier to simplify and to evaluate.

EXAMPLE Evaluate $\log_7\left(\frac{1}{49}\right)$. *A fraction is division, so I can split the log with division inside into two logs using subtraction (rule 4).* $\log_7\left(\frac{1}{49}\right) = \log_7 1 - \log_7 49$ *Base 7 to **what power** will equal 1?* $7^{\boxed{0}} = 1.$ *Base 7 to **what power** will equal 49?* $7^{\boxed{2}} = 49.$ *So…* $\log_7\left(\frac{1}{49}\right) = \log_7 1 - \log_7 49$ $= 0 - 2 = \boxed{-2}$	10. Evaluate $\log_2\left(\frac{1}{16}\right)$.	11. Evaluate $\log_5\left(\frac{1}{625}\right)$.
EXAMPLE Evaluate $\log_3(243)$. *When a number is too big, make it smaller. The base is 3, so use that…* $243 \div 3 = 81$, so $(3)(81) = 243$ $\log_3(243) = \log_3\big((3)(81)\big)$ *I can split 1 log with multiplication inside into 2 logs by addition (rule 3).* $\log_3(243) = \log_3\big((3)(81)\big)$ $= \log_3(3) + \log_3(81)$ *Base 3 to **what power** will equal 3?* $3^{\boxed{1}} = 3.$ *Base 3 to **what power** will equal 81?* $3^{\boxed{4}} = 81.$ *So…* $= \log_3(3) + \log_3(81)$ $= 1 + 4 = \boxed{5}$	12. Evaluate $\log_8 512$.	13. Evaluate $\log_5 3125$.

EXAMPLE Evaluate $\log_4(16^5)$. *An exponent in a logarithm moves to the front and multiplies.* $\log_4(16^5) = 5\log_4 16 = 5(2) = \boxed{10}$	14. Evaluate $\log_3(27^7)$.	15. Evaluate $\log_2(32^9)$.
EXAMPLE Evaluate $\log_6(216^{11})$. $\log_6(216^{11}) = 11\log_6 216$ $= 11(3) = \boxed{33}$	16. Evaluate $\log_8(64^3)$.	17. Evaluate $\log_3(81^6)$.

To determine the value of an exponent, you can use logarithms. To determine the value of more than one exponent, then you need to find a **common base** (a log base that is a base for both of the exponent bases), and use that as the base of the logarithm.

EXAMPLE Evaluate $4^x = 8^{x+3}$. *Find the common base of 4 & 8…* *4 is a base for 4* $(4^1 = 4)$, *but not 8* $(4^{NOPE} = 8)$. *2 is a base for 4* $(2^2 = 4)$, *and 8* $(2^3 = 8)$. *So, use 2…* $4^x = 8^{x+3}$ $\log_2(4^x) = \log_2(8^{x+3})$ *Move the exponents forward…* $x\log_2 4 = (x+3)\log_2 8$ *Simplify the logarithms…* $x(2) = (x+3)(3)$ $2x = 3x + 9$ $-x = 9$ $x = \boxed{-9}$	18. Evaluate $27^x = 9^{x-5}$.	19. Evaluate $125^x = 625^{x-5}$.
EXAMPLE Evaluate $81^{x+7} = 27^{x-4}$. *Find the common base of 81 & 27…* *9 is a base for 81* $(9^2 = 81)$, *but not 27* $(9^{NOPE} = 27)$. *3 is a base for 81* $(3^4 = 81)$, *and 27* $(3^3 = 27)$. *Use 3…* $81^{x+7} = 27^{x-4}$ $\log_3(81^{x+7}) = \log_3(27^{x-4})$ *Move the exponents forward…* $(x+7)\log_3 81 = (x-4)\log_3 27$ *Simplify the logarithms…* $(x+7)(4) = (x-4)(3)$ $4x + 28 = 3x - 12$ $x + 28 = -12$ $x = \boxed{-40}$	20. Evaluate $32^{x-2} = 4^{x-2}$.	21. Evaluate $16^{x+8} = 64^{x-1}$.