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LOGARITHMIC EQUATION AND METHODS OF SOLVING THEM

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Annotation: In this article, we discuss what logarithms are, what they apply to and how to solve logs in expressions and equations.
Key words: logarithms, logs, equations.

Logarithms are mathematical functions that transpose an exponential function to make it easier to solve. When computing algebraic equations involving exponents, logarithms serve as a valuable tool to compute unknown variables quickly while using as few mathematical components as possible. While larger logarithmic functions can require using a graphing calculator or computational software, basic logs are simple expressions that involve a few steps to compute.

A logarithm has several key elements. Looking at the example of *log2_4*, the leading term "log" indicates you're working with a logarithmic function, while the subscript of 2 shows you the base. The 4 indicates the power you apply to the two. Therefore, the corresponding exponential function of the example logarithm would be 2^4, or *2 x 2 x 2 x 2 =16*. The function *log2_4* equals 16. These elements are essential as you work with more complex logarithms involving unknown variables.

Use the following steps to simplify logarithmic expressions:
1. Identify the base and the power
In a basic log, you can decompose the expression into its related exponential function to simplify. In the logarithm, find the base as the subscript of the log term. For instance, in the expression *log7_3*, the subscript of 7 represents the base. Looking at the logarithm, identify the exponential value in the expression. This is the power you apply to the base. In the example logarithm *log7_3*, the 3 is the power to which you raise the base of 7. When writing this log in exponent form, the example would be *7^3*.

2. Simplify by multiplying

Once you identify the base and power in the log, simplify the operation. Using the expression *log7_3*, simplify the exponential equivalent *7^3 = 7 x 7 x 7* to get 343. This process is the most basic for solving logarithmic expressions and is essential when advancing into higher-level concepts that apply logs in algebraic equations.

3. Apply the process to larger expressions

Logarithmic expressions can get larger and include more terms, in which case you can apply the same steps as you do when solving basic functions. As an example, consider the expression *(log5_3) + (log2_2)*. You can decompose the function to its exponential form to get *(53) + (22)*. Simplifying this gives you *(5 x 5 x 5) + (2 x 2) = (125 + 4) = 129*. While these examples provide numerical values that are less complex to work with, logs can include unknown values that require additional steps to this process to isolate variables.

4. Use the variable rules

When solving log expressions that have variables, apply the rules for combining like terms with exponents. For instance, the expression *(loga_3) + (loga_3) + (loga_4)* converts to *a^3 + a^3 + a^4*. Using the rules for like terms with exponents gives the solution *2a^3 + a^4*. This is as far as this variable expression simplifies until you find the unknown values to calculate the variable powers.

Use the steps below to solve logs in equations:

1. Apply the log rules to combine like terms

In logarithmic equations, you may often encounter variables that represent unknown values. The log in these problems solves for the variable to give it a numerical value. When looking at a log equation, it's important to combine like terms using the logarithm rules. These are standards that provide a framework for working through a series of operations within a log. Using the example equation *log7.1_(X - 1) + log7.1_(3) = log7.1_(X + 1)* and the log rules, you can combine the first two terms of the equation. This gives you *log7.1_(3(X - 1)) = log7.1_(X + 1)*.

2. Simplify the resulting mathematical operations

Once you combine all like terms, perform any distributive operations to multiply algebraic factors together. Using the previous example, distributing the 3 on the left side of the equal sign gives you *log7.1_(3X - 3) = log7.1_(X + 1)*. Once you simplify the remaining operations of a logarithm, you can isolate and solve for the variable.

3. Balance the equation to isolate the variable

Some logs carry a variable on both sides of the equal sign. In these cases, balance the equation to isolate the variable on one side of the equal sign. In the example *log7.1_(3X - 3) = log7.1_(X + 1)*, the variable *X* is on both sides of the equal sign. Set up a linear equation to show *(3X - 3) = (X + 1)* and solve for the variable. This gives you *2X = 4*, resulting in the solution of *X = 2*. Whether you have an equation with a variable on one or both sides of the equal sign, you still isolate and solve for the unknown value.

4. Use the result to check the log

Now that you have the value for *X*, substitute the result in the original equation to ensure it's correct. In the original log, this looks like *log7.1_(2 - 1) + log7.1_(3) = log7.1_(2 + 1)*. Simplifying the equation results in *log7.1_(1) + log7.1_(3) = log7.1_(3)* and then *log7.1_(3) = log7.1_(3)*. This makes a true statement because both logarithms match on either side of the equal sign, proving the solution works.

Equations with logarithms on one side take $\log_b M = n \Rightarrow M = b^n$.
To solve this type of equations, here are the steps:

- Simplify the logarithmic equations by applying the appropriate laws of logarithms.

- Rewrite the logarithmic equation in exponential form.
- Now simplify the exponent and solve for the variable.
- Verify your answer by substituting it back in the logarithmic equation. You should note that the acceptable answer of a logarithmic equation only produces a positive argument.

Example 1

Solve $\log_2(5x + 7) = 5$

Solution

Rewrite the equation to exponential form

$\log_2(5x + 7) = 5 \Rightarrow 2^5 = 5x + 7$

$\Rightarrow 32 = 5x + 7$

$\Rightarrow 5x = 32 - 7$

$5x = 25$

Divide both sides by 5 to get

$x = 5$

Example 2

Solve for x in log (5x -11) = 2

Solution

Since the base of this equation is not given, we therefore assume the base of 10.

Now change the write the logarithm in exponential form.

$\Rightarrow 10^2 = 5x - 11$

$\Rightarrow 100 = 5x - 11$

$111 = 5x$

$111/5 = x$

Hence, x = 111/5 is the answer.

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