

Using exponential and logarithmic functions worksheet

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13) $16^{x-7} + 5 = 24$

14) $20^{-6x} + 6 = 55$

15) $5 \cdot 6^{3m} = 20$

16) $8^{-5x} - 5 = 53$

17) $3.4e^{2-2n} - 9 = -4$

18) $-6e^{8n+8} - 3 = -23$

19) $-e^{-3.9x-1} - 1 = -3$

20) $-2e^{7x+5} - 10 = -17$

21) $-3e^{7x+9} + 6 = -6$

22) $-3e^{9x-1} + 6 = -58$

23) $-e^{6-9x} + 5 = -48.4$

24) $-10e^{1-2x} - 6 = -66$

25) $6e^{-4x-10} - 4 = 63$

26) $6e^{5x-6} - 4 = 50$

-2-

Name: _____ Score: _____

(Logarithmic & Exponential Form)

Express each equation in logarithmic form.

1) $5^x = 25$	2) $3^y = 6$
3) $3^z = \frac{1}{27}$	4) $4^w = 64$
5) $3^x = 9$	6) $2^y = 64$
7) $6^x = 216$	8) $2^z = \frac{1}{12}$

Express each equation in exponential form.

9) $\log_2 32 = 5$	10) $\log_2 256 = 8$
11) $\log_3 125 = 3$	12) $\log_2 x = \frac{1}{2}$
13) $\log_5 27 = 3$	14) $\log_{\frac{1}{2}}(\frac{1}{16}) = -3$
15) $\log_{\frac{1}{3}}(\frac{1}{27}) = -3$	16) $\log_8 1000 = 3$

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Is this function linear, quadratic, or exponential?

x	y
1	1.7
2	3.4
3	6.8
4	13.6
5	27.2

linear

quadratic

exponential

Name: _____ Score: _____
Teacher: _____ Date: _____

Exponential Equation Solving with Logarithms

Solve each equation. Round answers to the nearest ten-thousandth.

1) $3e^{-2m+4} - 1 = 15$

8) $15^{4n+8} + 8 = 22$

2) $12^p = 16$

9) $e^{6.4} + 8 = 23$

3) $5 \cdot 6^{-3m} = 17$

10) $4^b = 24$

4) $8^{x+10} - 10 = 18$

11) $4^{-4y+8} - 1 = 25$

5) $2 \cdot 3^{-2p} = 19$

12) $16^{p+1} + 8 = 26$

6) $15^d = 20$

13) $e^{4.6} - 4 = 27$

7) $9^{2x+4} - 3 = 21$

14) $4e^{-4x+3} + 6 = 28$

Summary of Logarithmic Properties
(for all formulas, x , y , and b , are all > 0 , a and $b \neq 1$)

Product Rule:	$\log_b(xy) = \log_b x + \log_b y$	Remember, if you multiply inside the parentheses, you add logs on the outside.
Division Rule:	$\log_b\left(\frac{x}{y}\right) = \log_b x - \log_b y$	Remember, if you divide inside the parentheses, you subtract logs on the outside.
Power Rule:	$\log_b(x^a) = a \log_b x$	Remember, if you raise to a power inside the parentheses, you multiply by that power on the outside.
Change of Base Rule:	$\log_a(x) = \frac{\log_b x}{\log_b a}$ or $\log_a(x) = \frac{\ln x}{\ln b}$	Remember, put the larger number (argument) on top, the smaller (base) on bottom. This is useful for the calculator if you don't have the LOGBASE function.

Examples of exponential and logarithmic functions in real life.

The logarithmic function is an important medium of math calculations. Logarithms were discovered in the 16th century by John Napier a Scottish mathematician, scientist, and astronomer. It has numerous applications in astronomical and scientific calculations involving huge numbers. Logarithmic functions are closely related to exponential functions and are considered as an inverse of the exponential function. The exponential function $ax = N$ is transformed to a logarithmic function $\log_a N = x$. The logarithm of any number N if interpreted as an exponential form, is the exponent to which the base of the logarithm should be raised, to obtain the number N . Here we shall aim at knowing more about logarithmic functions, types of logarithms, the graph of the logarithmic function, and the properties of logarithms. What are Logarithmic Functions? The basic logarithmic function is of the form $f(x) = \log_a(x)$ where $a > 0$. It is the inverse of the exponential function $ay = x$. Log functions include natural logarithm (\ln) or common logarithm (\log). Here are some examples of logarithmic functions: $f(x) = \ln(x - 2)$ $g(x) = \log_2(x + 5) - 2$ $h(x) = 2 \log x$, etc. Some of the non-integral exponent values can be calculated easily with the use of logarithmic functions. Finding the value of x in the exponential expressions $2x = 8$, $2x = 16$ is easy, but finding the value of x in $2x = 10$ is difficult. Here we can use log functions to transform $2x = 10$ into logarithmic form as $\log 210 = x$ and then find the value of x . The logarithm counts the number of occurrences of the base in repeated multiples. The formula for transforming an exponential function into a logarithmic function is as follows. The exponential function of the form $ax = N$ can be transformed into a logarithmic function $\log_a N = x$. The logarithms are generally calculated with a base of 10, and the logarithmic value of any number can be found using a Napier logarithm table. The logarithms can be calculated for positive whole numbers, fractions, decimals, but cannot be calculated for negative values. Domain and Range of Log Functions Let us consider the basic (parent) common logarithmic function $f(x) = \log x$ ($y = \log x$). We know that $\log x$ is defined only when $x > 0$ (try finding $\log 0$, $\log(-1)$, $\log(-2)$, etc using your calculator. You will come up with an error). So the domain is the set of all positive real numbers. Now, we will observe some of the y -values (outputs) of the function for different x -values (inputs). When $x = 1$, $y = \log 1 = 0$. When $x = 2$, $y = \log 2 = 0.3010$. When $x = 0.2$, $y = -0.6990$. When $x = 0.01$, $y = -2$, etc. We can see that y can be either a positive or negative real number (or) it can be zero as well. Thus, y can take the value of any real number. Hence, the range of a logarithmic function is the set of all real numbers. That is, the domain of a logarithmic function $y = \log x$ is $x > 0$ and the range is $y \in \mathbb{R}$. The range of a log function is the set of all real numbers (R). Example: Find the domain and range of the logarithmic function $f(x) = 2 \log(2x - 1) + 5$. Solution: The domain of the function is $2x - 1 > 0 \Rightarrow x > 0.5$, thus, domain = $(2, \infty)$. As we have seen earlier, the range of any log function is R. So the range of $f(x)$ is R. Graph of $y = \log x$ We have already seen that the domain of the basic logarithmic function $y = \log x$ is the set of positive real numbers and the range is the set of all real numbers. We know that the exponential and log functions are inverses of each other and hence their graphs are symmetric with respect to the line $y = x$. Also, note that $y = 0$ when $x = 0$ as $y = \log x = 0$ for $x > 0$. Thus, all such functions have an x -intercept of $(1, 0)$. A logarithmic function doesn't have a y -intercept as $\log 0$ is not defined. Summarizing all these, the graphs of exponential functions and logarithmic graph look like below. Properties of Logarithmic Graph a > 0 and a ≠ 1 The logarithmic graph increases when a > 1, and decreases when 0 < a < 1. The domain is obtained by setting the argument of the function greater than 0. The range is the set of all real numbers. Graphing Logarithmic Functions Before drawing a log function graph, just have an idea of whether you get an increasing curve or decreasing curve as the answer. If the base > 1, then the curve is increasing; and if 0 < base < 1, then the curve is decreasing. Here are the steps for graphing logarithmic functions: Find the domain and range. Find the vertical asymptote by setting the argument equal to 0. Note that a log function doesn't have any horizontal asymptote. Substitute some value of x that makes the argument equal to 1 and use the property $\log a = 1$. This gives us the x -intercept. Substitute some value of x that makes the argument equal to the base and use the property $\log a = 1$. This would give us a point on the graph. Join the two points (from the last two steps) and extend the curve on both sides with respect to the vertical asymptote. Example: Graph the logarithmic function $f(x) = 2 \log_3(x + 1)$. Solution: Here, the base is 3 > 1. So the curve would be increasing. For domain: $x + 1 > 0 \Rightarrow x > -1$. So domain = $(-1, \infty)$. Range = R. Vertical asymptote is $x = -1$. At $x = 0$, $y = 2 \log_3(0 + 1) = 2 \log_3 1 = 2(0) = 0$ At $x = 2$, $y = 2 \log_3(2 + 1) = 2 \log_3 3 = 2(1) = 2$ If we want more clarity, we can form a table of values with some random values of x and substitute each of them in the given function to compute the y -values. This way, we get more points on the graph and it helps in getting the perfect shape of the graph. Thus, $(0, 0)$ and $(2, 2)$ are two points on the curve. Thus, the log function graph looks as follows. Properties of Logarithmic Functions Logarithmic function properties are helpful to work across complex log functions. All the general arithmetic operations across numbers are transformed into a different set of operations within logarithms. The product of two numbers, when taken within the logarithmic functions is equal to the sum of the logarithmic values of the two functions. Similarly, the operations of division are transformed into the difference of the logarithms of the two numbers. Let us list the important properties of log functions in the below points. $\log ab = \log a + \log b$ $\log(a/b) = \log a - \log b$ $\log(a^b) = b \log a$ $\log(a/c) = \log a - \log c$ Derivative and Integral of Logarithmic Functions The derivation of the logarithmic function gives the slope of the tangent to the curve representing the logarithmic function. The formula for the derivative of the common and natural logarithmic functions are as follows: The integral of $\ln x$ is $\int \ln x dx = x(\ln x - 1) + C$. Related Topics: Exponents Exponent Rules Properties of Logarithms Logs in Calculations Example 1: Express 43 = 64 in logarithmic form. Solution: The exponential form $ax = N$ can be written in logarithmic form as $\log_a N = x$. Hence, $43 = 64$ can be written in logarithmic form as $\log_4 64 = 3$. Answer: $\log_4 64 = 3$ Example 2: Simplify $\log_2(1/128)$. Solution: We use the properties of logarithmic function to simplify the given logarithm. $\log_2(1/128) = \log_2 1 - \log_2 128 = 0 - \log_2 27 = -\log_2 27 = -7$. Thus, $\log_2 27 = -7$ (1) = -7 Answer: Hence $\log_2(1/128) = -7$ Example 3: Find the domain, range, vertical and horizontal asymptotes of the logarithmic function $f(x) = 3 \log_2(2x - 3) - 7$. Solution: For domain: $2x - 3 > 0 \Rightarrow x > 3/2$. Hence domain = $(3/2, \infty)$. The range of any log function is $(-\infty, \infty)$. For vertical asymptote (VA), $2x - 3 = 0 \Rightarrow x = 3/2$. A logarithmic graph never has a horizontal asymptote (HA). Answer: Domain = $(3/2, \infty)$; Range = $(-\infty, \infty)$; VA is $x = 3/2$; No HA. View More > go to slidego to slidego to slide Breakdown tough concepts through simple visuals. Math will no longer be a tough subject, especially when you understand the concepts through visualizations. Book a Free Trial Class FAQs on Logarithmic Functions The logarithmic function can be solved using the logarithmic formulas. The product of functions within logarithms is equal ($\log(ab) = \log a + \log b$) to the sum of two logarithms. The division of two logarithm functions ($\log(a/b) = \log a - \log b$) is changed to the difference of logarithm functions. The logarithm functions can also be solved by changing it to exponential form. How to Graph Logarithmic Functions? The graph of $y = \log x$ can be obtained by finding its domain, range, asymptotes, and some points on the curve. To find some points on the curve we can use the following properties: What are Asymptotes of a Logarithmic Function? Here are the asymptotes of a logarithmic function $f(x) = \log(x - b) + c$: The vertical asymptote is $x = b$. There is no horizontal asymptote. How Are Exponential and Logarithmic Functions Related? The exponential function of the form $ax = N$ can be transformed into a logarithmic function $\log_a N = x$. Here the exponential functions $2x = 10$ is transformed into logarithmic form as $\log 210 = x$, to find the value of x . The logarithm counts the number of occurrences of the base in repeated multiples. What is the Difference Between Natural Logarithmic and Common Logarithmic Functions? The logarithmic functions are broadly classified into two types, based on the base of the logarithms. We have natural logarithms and common logarithms. Natural logarithms are logarithms to the base 'e', and common logarithms are logarithms to the base of 10. Further logarithms can be calculated with reference to any base, but are often calculated for the base of either 'e' or '10'. The natural logarithms are written as $\ln x$ or $\log_e x$. The common logarithms are written as $\log x$ or $\log_{10} x$. To obtain the value of x from natural logarithms, it is equal to the power to which e has to be raised to obtain $x = e^x$. For example, $\ln 2 = 0.6931471805533989$, but is often written in short as $e = 2.718281828459$, which is the value of e . The above formulas help in the interconversion of natural logarithms and common logarithms. How to Differentiate Logarithmic Functions? The differentiation of a logarithmic function results in the inverse of the function. The differentiation of $\ln x$ is equal to $1/x$. The antiderivative of $1/x$ gives back the function. What Is the Range of Logarithmic Functions? The range of a logarithmic function takes all values, which include the positive and negative real numbers. Thus, the range of the logarithmic function is from negative infinity to positive infinity. What Is the Domain of Logarithmic Functions? The domain of a logarithmic function is the set of all positive real numbers. What Is the Formula for Logarithmic Functions? The following formulas are helpful to work and solve the log functions. $\log ab = \log a + \log b$ $\log(a/b) = \log a - \log b$ $\log(a^b) = b \log a$ What Are Logarithmic Functions Used For? Logarithmic functions have numerous applications in physics, engineering, astronomy. The numeric measurements in astronomy include huge numbers with decimals and exponents. The huge scientific calculations can be easily simplified and calculated using log functions. The logarithmic functions help in transforming the product and division of numbers into sum and difference of numbers.

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