I'm not a robot



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Home>Logarithm Rules - Explanation & Examples Nothing messes up an equation quite like logarithms. They are cumbersome, difficult to manipulate and a little mysterious for some people. Luckily, there's an easy way to rid your equation of these pesky mathematical expressions. All you have to do is remember that a logarithm is the inverse of an
exponent. Although the base of a logarithm can be any number, the most common bases used in science are 10 and e, which is an irrational number known as Euler's number. To distinguish them, mathematicians use "log" when the base is e. To rid an equation of logarithms, raise both sides to the same exponent as the
base of the logarithms. In equations with mixed terms, collect all the logarithm is the number of times you have to multiply a number by itself to get another number. Another way to say it is that a logarithm is the power to which a
 certain number - called the base - must be raised to get another number. The power is called the argument of the logarithm. For example, log82 = 64 simply means that raising 8 to the power of 2 gives 64. In the equation log x = 100, the base is understood to be 10, and you can easily solve for the argument, x because it answers the question, "10
raised to what power equals 100?" The answer is 2. A logarithm is the inverse of an exponent. The equation log x = 100. This relationship makes it possible to remove logarithms from an equation by raising both sides to the same exponent as the base of the logarithm. If the equation contains more than one
logarithm, they must have the same base for this to work. In the simplest case, the logarithm of an unknown number equals another number: \(\log x = y\) Raise both sides to exponents of 10, and you get \(10^ {\log x} = 10^y\) When all the terms in the equation are logarithms, raising
both sides to an exponent produces a standard algebraic expression. For example, raise \(\log (x^2 - 1) = \log (x + 1)\) to a power of 10 and you get: \(x^2 - 1 = x + 1\) which simplifies to \(x^2 - x - 2 = 0.\) The solutions are x = -2; x = 1. In equations that contain a mixture of logarithms and other algebraic terms, it's important to collect all the
logarithms on one side of the equation. You can then add or subtract terms. According to the law of logarithms, the following is true: (x + \log y = \log(xy) \setminus \log x - \log x = \log(xy) \setminus \log x - \log x = \log(xy) \setminus \log x - \log x = \log(xy) \setminus \log x - \log(xy) = \log(xy) + \log(xy) = \log(xy) + \log(xy) + \log(xy) = \log(xy) + \log(xy) 
terms: (\log x - \log (x - 2) = 3) Apply the law of logarithms: (x + 2) Baise both sides to a power of 10: (x + 2) Baise both sides to a power of 10: (x + 2) Baise both sides to a power of 10: (x + 2) Baise both sides to a power of 10: (x + 2) Baise both sides to a power of 10: (x + 2) Baise both sides to a power of 10: (x + 2) Baise both sides to a power of 10: (x + 2) Baise both sides to a power of 10: (x + 2) Baise both sides to a power of 10: (x + 2) Baise both sides to a power of 10: (x + 2) Baise both sides to a power of 10: (x + 2) Baise both sides to a power of 10: (x + 2) Baise both sides to a power of 10: (x + 2) Baise both sides to a power of 10: (x + 2) Baise both sides to a power of 10: (x + 2) Baise both sides to a power of 10: (x + 2) Baise both sides to a power of 10: (x + 2) Baise both sides to a power of 10: (x + 2) Baise both sides to a power of 10: (x + 2) Baise both sides to a power of 10: (x + 2) Baise both sides to a power of 10: (x + 2) Baise both sides to a power of 10: (x + 2) Baise both sides to a power of 10: (x + 2) Baise both sides to a power of 10: (x + 2) Baise both sides to a power of 10: (x + 2) Baise both sides to a power of 10: (x + 2) Baise both sides to a power of 10: (x + 2) Baise both sides to a power of 10: (x + 2) Baise both sides to a power of 10: (x + 2) Baise both sides to a power of 10: (x + 2) Baise both sides to a power of 10: (x + 2) Baise both sides to a power of 10: (x + 2) Baise both sides to a power of 10: (x + 2) Baise both sides to a power of 10: (x + 2) Baise both sides to a power of 10: (x + 2) Baise both sides to a power of 10: (x + 2) Baise both sides to a power of 10: (x + 2) Baise both sides to a power of 10: (x + 2) Baise both sides to a power of 10: (x + 2) Baise both sides to a power of 10: (x + 2) Baise both sides to a power of 10: (x + 2) Baise both sides to a power of 10: (x + 2) Baise both sides to a power of 10: (x + 2) Baise both sides to a power of 10: (x +
27 October 2020. APA Deziel, Chris. (2020, October 27). How To Get Rid Of Logarithms. sciencing.com. Retrieved from Chicago Deziel, Chris. How To Get Rid Of Logarithms last modified August 30, 2022. Share — copy and redistribute the material in any medium or format for any purpose, even commercially. Adapt — remix, transform, and build
upon the material for any purpose, even commercially. The licensor cannot revoke these freedoms as long as you follow the license terms. Attribution — You must give appropriate credit, provide a link to the license terms. Attribution in any way that suggests the license endorses
you or your use. ShareAlike — If you remix, transform, or build upon the material, you must distribute your contributions under the same license as the original. No additional restrictions — You may not apply legal terms or technological measures that legally restrict others from doing anything the license permits. You do not have to comply with the
 license for elements of the material in the public domain or where your use is permitted by an applicable exception or limitation. No warranties are given. The license may not give you all of the permissions necessary for your intended use. For example, other rights such as publicity, privacy, or moral rights may limit how you use the material. acidic:
An adjective for materials that contain acid. These materials often are capable of eating away at some minerals such as carbonate, or preventing their formation in the first place. base: (in math) A number to be multiplied by itself in a logarithmic statement (and shown as a subscript to the lower right of the base number) or by the number of times
called for by an exponent (shown as a superscript to the upper right of that base number). (in chemistry) A chemical that produces hydroxide ions (OH-) in a solution. Basic solutions are also referred to as alkaline. (in genetics) A shortened version of the term nucleobase. These bases are building blocks of DNA and RNA molecules. binary: Something
having two integral parts. (in mathematics and computer science) A number system where values are represented using two symbols 1 (on) or 0 (off). chemistry: The field of science that deals with the composition, structure and properties of substances, to reproduce
large quantities of useful substances or to design and create new and useful substances. Computer scientists who work in this field are known as computer scientists. Coronavirus: A family of viruses named for the crown-like spikes on their surface (corona means "crown" in Latin).
Coronaviruses cause the common cold. The family also includes viruses that cause far more serious infections, including SARS. COVID-19: A name given the coronavirus that caused a massive outbreak of potentially lethal disease, beginning in December 2019. Symptoms included pneumonia, fever, headaches and trouble breathing. data: Facts and/or
statistics collected together for analysis but not necessarily organized in a way that gives them meaning. For digital information (the type stored by computers), those data typically are numbers stored in a binary code, portrayed as strings of zeros and ones. decibel: A measurement scale used for the intensity of sounds that can be picked up by the
human ear. It starts at zero decibels (dB), a sound 10 times louder than 0 dB would be 20 dB; one that's 1,000 times louder than 0 dB would be described as 30 dB. digit: (in math) An individual numeral (from 0 to 9) used to
represent a number or some part of a number. e: A mathematical constant that never changes. It is roughly, 2.718281828459. e stands for Euler's number of a natural logarithm. earthquake: A sudden and sometimes violent shaking of the ground, sometimes causing great destruction, as a
result of movements within Earth's crust or of volcanic action. economics: The social science that deals with the production, distribution and consumption of goods and services and with the production, distribution and consumption of goods and services and with the production, distribution and consumption of goods and services and with the production, distribution and consumption of goods and services and with the production, distribution and consumption of goods and services and with the production, distribution and consumption of goods and services and with the production, distribution and consumption of goods and services and with the production, distribution and consumption of goods and services and with the production, distribution and consumption of goods and services and with the production, distribution and consumption of goods and services and with the production, distribution and consumption of goods and services and with the production and consumption of goods and services and with the production and consumption of goods and services and with the production and consumption of goods and services and with the production and consumption of goods and services and with the production and consumption of goods and services and with the production and consumption of goods and services and consumption of goods and services are consumption of goods are consumption o
resources (people, jobs, land, forests and minerals, for instance) of a nation or region. It is often measured in terms of jobs and income or internet access).
electrons. exponent: A number, shown as a superscript (tiny number or expression must be multiplied by itself. expression: (in mathematics) A statement that involves combinations of numbers and/or letters (that
signify numbers that may vary) and includes directions (or rules) about what to do with those numbers (such as add or divide them, take their logarithm or make combinations of them equal one another). infection: A disease that can spread from one organism to another. It's usually caused by some type of germ. inverse: Something that is the opposite
or reverse of another thing, or that moves in the opposite direction to something. irrational: (in math) A number end or repeat. Examples are π (pi), the ratio of a circle's diameter to its circumference (3.14159...), and e, Euler's number
(2.71828...). log: (in math) An abbreviation for logarithm for logarithm for logarithm of 100, in a base 10 system, is 2. In base 10, the logarithm of
1,000 would be 3, the log of 10,000 would be 4, and so on. magnitude: (in geology) A number used to describe the relative size of an earthquake. It runs from 1 to more than 8 and is calculated by the peak ground motion as recorded by seismographs. There are several magnitude scales. One of the more commonly used ones today is known as the
 moment magnitude. It's based on the size of a fault (crack in Earth's crust), how much the fault slips (moves) during a quake, and the energy force that was required to permit that movement. For each increase in magnitude, an earthquake produces 10 times more ground motion and releases about 32 times more energy. For perspective, a magnitude
8 quake can release energy equivalent to detonating 6 million tons of TNT. numerical: Having to do with numbers. octave: (in music) The interval between one note and the note with twice its frequency. There are actually 12 half steps in an octave, all the same size. Octaves are a pattern of sound differentiations typical of Northern and Western
music. pandemic: An epidemic that affects a large proportion of the population across a country or the world. perception: The state of being aware of something — through use of the senses. pH: A measure of a solution's acidity or alkalinity. A pH of 7 is perfectly neutral. Acids have a pH lower than 7;
the farther from 7, the stronger the acid. Alkaline solutions, called bases, have a pH higher than 7; again, the farther above 7, the stronger the base. place value system: (in math) Numbers are expressed using 10 symbols — 0 to 9 — known as digits. When a number gets to be 10 or higher, no new symbols are used. Instead, we start a new column of
digits to the left, which describes how many 10's are in this number. After that, we write the digit indicating how many 1's follow it. So the number exceeds 99, a new column is needed to identify the number of 100's, followed
by the number of 10's and 1's. And each time a number exceeds the spaces available, a new column is added, allowing us to show 1,000's, 10,000's, 100,000's, 100,000'
energy from one place to another. Unlike conduction and convection, which need material to help transfer energy across empty space. SARS-CoV-2: A coronavirus that emerged in Wuhan, China, in late December 2019. It would go on to cause widespread — and sometimes lethal — disease throughout China and many space.
other nations. Its name reflects its close similarity to the original coronavirus known as SARS (for severe acute respiratory syndrome). That SARS virus sparked a global outbreak of disease in 2003. sound wave: A wave that transmits sound. Sound waves have alternating swaths of high and low pressure. statistics: The practice or science of collecting
and analyzing numerical data in large quantities and interpreting their meaning. Much of this work involves reducing errors that might be attributable to random variation. A professional who works in this field is called a statistician. seismic wave: A wave traveling through the ground produced by an earthquake or some other means. theory: (in
 science) A description of some aspect of the natural world based on extensive observations, tests and reason. A theory can also be a way of organizing a broad body of knowledge that applies in a broad range of circumstances to explain what will happen. Unlike the common definition of theory, a theory in science is not just a hunch. Ideas or
conclusions that are based on a theory — and not yet on firm data or observations — are referred to as theorists. virus: Tiny infectious particles consisting of RNA or DNA surrounded by protein. Viruses can reproduce only by
injecting their genetic material into the cells of living creatures. Although scientists frequently refer to viruses as live or dead, in fact no virus is truly alive. It doesn't eat like animals do, or make its own food the way plants do. It must hijack the cellular machinery of a living cell in order to survive. wave: A disturbance or variation that travels through
space and matter in a regular, oscillating fashion. In its simplest form, a logarithm answers the question: How many 2s multiply together to make 8? Answer: 2 × 2 × 2 = 8, so we had to multiply 3 of the 2s to get 8 So the logarithm is 3 How to Write it like this:
log2(8) = 3 So these two things are the same: The number we multiply is called the "base", so we can say: "the logarithm of 8 with base 2 is 3" or "log base 2 of 8 is 3" or "log base 2 of 8 is 3" Notice we are dealing with three numbers: the base: the number we are multiplying (a "2" in the example above) how often to use it in a multiplication (3
 In that example the "base" is 2 and the "exponent" is 3: So the logarithm answers the question: What is \log 10(100) ... ? 102 = 100 So an exponent of 2 is needed to make 10 into 100, and: \log 10(100) = 2 Example: What is \log 3(81) ... ? 34 = 81 So
an exponent of 4 is needed to make 3 into 81, and: log3(81) = 4 Common Logarithms: Base 10 Sometimes a logarithm is written without a base, like this: log(100) This usually means that the base is really 10. It is called a "common logarithm". Engineers love to use it. On a calculator it is the "log" button. It is how many times we need to use 10 in a
multiplication, to get our desired number. Example: log(1000) = log10(1000) = 3 Natural Logarithms: Base "e" Another base that is often used is e (Euler's Number) which is about 2.71828. This is called a "natural logarithm". Mathematicians use this one a lot. On a calculator it is the "ln" button. It is how many times we need to use "e" in a
multiplication, to get our desired number. Example: \ln(7.389) \approx 2 Because 2.718282 \approx 7.389 But Sometimes There Is Confusion ...! Mathematicians may use "log" (instead of "ln") to mean the natural logarithm. This can lead to confusion ...! Mathematicians may use "log" (instead of "ln") to mean the natural logarithm.
 loge(50) loge(50) no confusion log10(50) log10(50) log10(50) log10(50) log10(50) no confusion So, be careful when you read "log" that you know what base they mean! Logarithms (like 2 or 3), but logarithms can have decimal values like 2.5, or 6.081, etc. Example: what is log10(26) ... ? Get
your calculator, type in 26 and press log Answer is: 1.41497... The logarithm is saying that 101.41497... = 26 (10 with an exponent of 1.41497... equals 26) This is what it looks like on a graph: See how nice and smooth the line is. Read Logarithms Can Have Decimals to find out more. Negative Logarithms - Negative? But logarithms deal with
Multiplying and Dividing are all part of the same simple pattern. Let us look at some Base-10 logarithms as an example: Number How Many 10s Base-10 Logarithm .. etc..
                                                                                                                    Looking at that table, see how positive, zero or negative logarithms are really part of the same (fairly simple) pattern. The Word "Logarithm" is a word made up by Scottish mathematician John Napier (1550-1617), from the Middle Latin "logarithmus" meaning "ratio-number"! 340, 341, 2384
2385, 2386, 2387, 3180, 3181, 2388, 2389 Copyright © 2023 Rod Pierce Our online calculators, converters, randomizers, and content are provided "as is", free of charge, and without any warranty or guarantee. Each tool is carefully developed and rigorously tested, and our content is well-sourced, but despite our best effort it is possible they contain
errors. We are not to be held responsible for any resulting damages from proper or improper use of the service. See our full terms of service. Seroll down the page for more explanations and examples on how to use the rules to simplify and expand
 logarithmic expressions. Logarithm Worksheets Practice your Logarithm skills with the following worksheets: Printable & Online Logarithms of the factors. loga xy = loga x + loga y 2) Quotient Rule The logarithm of a quotient is the
 logarithm of the numerator minus the logarithm of the denominator. loga = loga x - loga y 3) Power Rule loga xn = nloga x 4) Change Of Base Rule where x and y are positive, and a > 0, a \neq 1 Example: Simplify the following, expressing each as a single logarithm: a) log 2 4 + log 2 5 b) log a 28 - log a 4 c) 2 log a 5 - 3 log a 2 Solution: a) log 2 4 + log
25 = \log 2 (4 \times 5) = \log 2 (20 \text{ b}) \log a 28 - \log 3 - \log 3 = \log 3
2.322, evaluate log4 15 Solution: loga 1 = 0 since a0 = 1 loga a = 1 since a1 = a loga ax = x since ax = ax The video explains explains and applies various property of logarithms. Product property: The log of a product equals the sum of the logs. Quotient
 Property: The log of a quotient equals the difference of the logarithm. Expand the logarithmic expression and how to write expression as a single logarithmic expression. log3(xy3/\sqrt{z}) Write as a single logarithmic expression and how to write expression and how to write expression.
 \ln(2x) Show Video Lesson Basic Logarithm Properties With Examples Examples: Expand the logarithmic expression. \ln(2x) Show Video Lesson How to take an expression involving multiple logarithms and write it as an expression containing only a single logarithm?
 Example: Rewrite as a single logarithm 5 lnx + 13 ln (x3 + 5) - 1/2 ln(x + 1) Show Video Lesson Try out our new and fun Fraction Concoction Game. Add
and subtract fractions to make exciting fraction concoctions following a recipe. There are four levels of difficulty: Easy, medium, hard and insane. Practice the basics of fraction addition and subtraction or challenge yourself with the insane level. We welcome your feedback, comments and questions about this site or page. Please submit your feedback
or enquiries via our Feedback page. The base b logarithm of x is equal to y: logb(x) = y For example when: 24 = 16 Then log2(16) = 4 Logarithm as inverse
function of exponential function The logarithm of the exponential function of the logarithm of the exponential function of the exponential function of x, f(f(x)) = f(x) = f(x) and f(x) = f(x) = f(x) for if we calculate the logarithm of the exponential function of f(x) = f(x) = f(x) for if we calculate the logarithm of f(x) = f(x) for if we calculate the logarithm of f(x) = f(x) for if we calculate the logarithm of f(x) = f(x) for if we calculate the logarithm of f(x) = f(x) for if we calculate the logarithm of f(x) = f(x) for if we calculate the logarithm of f(x) = f(x) for if we calculate the logarithm of f(x) = f(x) for if we calculate the logarithm of f(x) = f(x) for if f(x) = f(x) fo
 logarithm is a logarithm to the base e: \ln(x) = \log e(x) When e constant is the number: or See: Natural logarithm (or anti logarithm to the base b to the logarithm (or anti logarithm) is calculated by raising the base b to the logarithm (or anti logarithm) is calculated by raising the base b to the logarithm (or anti logarithm) is calculated by raising the base b to the logarithm (or anti logarithm) is calculated by raising the base b to the logarithm (or anti logarithm) is calculated by raising the base b to the logarithm (or anti logarithm) is calculated by raising the base b to the logarithm (or anti logarithm) is calculated by raising the base b to the logarithm (or anti logarithm) is calculated by raising the base b to the logarithm (or anti logarithm) is calculated by raising the base b to the logarithm (or anti logarithm) is calculated by raising the base b to the logarithm (or anti logarithm) is calculated by raising the base b to the logarithm (or anti logarithm) is calculated by raising the base b to the logarithm (or anti logarithm) is calculated by raising the base b to the logarithm (or anti logarithm) is calculated by raising the base b to the logarithm (or anti logarithm) is calculated by raising the base b to the logarithm (or anti logarithm) is calculated by raising the base b to the logarithm (or anti logarithm) is calculated by raising the base b to the logarithm (or anti-logarithm) is calculated by raising the base b to the logarithm (or anti-logarithm) is calculated by raising the logarithm (or anti-logarithm) is calculated by 
 rules Rule name Rule logb(x • y) = logb(x) + logb(y) logb(x / y) = logb(x) + logb(y) logb(x / y) = y • logb(x) logb(x) = 1 / logb(x) logb(x) logb(x) = 1 / logb(x) logb(x) logb(x) logb(x) logb(x) = 1 / logb(x) logb(x
 rules Logarithm product rule The logarithm of the multiplication of x and y is the sum of logarithm of y. logb(x • y) = logb(x) + logb(y) For example: log10(3) + log10(7) Logarithm of y. logb(x / y) = logb(x) - logb(y)
 Logarithm base change rule The base b logarithm of x is base c logarithm of x divided by the base c logarithm of b. logb(x) = \log 10(8) / \log 10(2) See: \log 10(8) / \log 10(8)
 when x go to slidego to slidego to slide Ready to see the world through math's eyes? Math is a life skill. Help your child perfect it through real-world application. Book a Free Trial Class FAQs on Log Rules are mentioned in the table below. Rule Name Log Rule
Log 1 log b 1 = 0 Log of a Number With Same Base log b m - log b
 multiple logarithms or compress multiple logarithms into a single logarithm, we use the logarithm rules. These rules are derived from the rules of exponents. What is the Product can be converted into a sum of logarithms. For
example: log2 (xyz) = log2 x + log2 y + log2 z. How to Convert a Negative log of an argument is the logarithm of the reciprocal of the argument. i.e., logb a = logb a-1 = logb (1/a). The negative log with a base is the logarithm
 whose base is the reciprocal of the given base. i.e., -\log b a = \log(1/b) a. What are the Rules of -\ln n the rules of -\ln n and -\ln n the rules of -\ln n the rule
 Rules? Here are the derivatives of different types of logarithms: What are 4 Important Logarithm Rules? We have many logarithm rules. Among them, the 4 important rules of common logs are as follows: log m + log m = log (mn) log m = m log a 10log x = x What is the Difference Between Log Rules and Natural Log Rules? In
fact, there is no difference between the rules of common logarithms and the rules of natural log is also a logarithm (just with base 'e'). The laws of logarithms are algebraic rules that allow for the simplification and rearrangement of logarithms are algebraic rules of natural log is also a logarithm (just with base 'e'). The laws of logarithms are algebraic rules that allow for the simplification and rearrangement of logarithms.
 = \log(m) + \log(n). The Quotient Law: \log(m/n) = \log(m) - \log(m). The Power Law: \log(m/n) = \log(m). The three fundamental laws of logarithms are shown below. The rules for the logarithms must be equal. The base of the logarithms must be greater than
zero. The base of the logarithms cannot be equal to 1. The inputs of the logarithms must be greater than zero. The loga(m) + loga(m) + loga(m) - loga(m) - loga(m) - loga(m) - loga(m) - loga(m) - loga(m) |
 important logarithm laws are shown below with an example of each. The product logarithms are multiplied to obtain 20. The quotient logarithm law: When subtracting logarithms with the same base, the first logarithm is
 divided by the logarithm being subtracted. 10 is divided by 5 inside the logarithm to obtain log(2). The power of the input to the power of 2 to obtain 25. The following table shows the complete list of log laws with examples of how they are
 used: Logarithm LawFormulaExampleProduct Lawloga(m) + \log(n) = \log(m)\log(2) + \log(3) = \log(3)Inverse Logarithm Propertyloga(ak) = \log(8) = \log(2) = \log(2) = \log(3)Inverse Logarithm Propertyloga(ak) = \log(8) = \log(2) = \log(2) = \log(3)Inverse Logarithm Propertyloga(ak) = \log(8) = \log(8) = \log(8)Inverse Logarithm Propertyloga(ak) = \log(8) = \log(8)Inverse Logarithm Propertyloga(ak) = \log(8) = \log(8) = \log(8) = \log(8)Inverse Logarithm Propertyloga(ak) = \log(8) = \log(8) = \log(8) = \log(8)Inv
 Reciprocalloga(1/m) = -\log(m)\log(1/2) = -\log(2) Identity Property of a Logarithm laws. The colours used in this list show how the different a visual list of 5 of the most commonly used logarithm laws. The colours used in this list show how the different laws.
 rearrangements are made in a more simple, visual manner. The following sections take a look at each of the logarithm laws in greater detail. The logarithms are: The Product RuleThe Inverse Property of the Exponent To add two or more
 logarithms that have the same base, simply multiply the numbers inside the logarithms. For example, \log(3) + \log(2) = \log(6). The result is a single logarithm with the same base as those being added. The formula for the product rule of logarithm with the same base as those being added. The formula for the product rule of logarithm with the same base as those being added.
 (product) rule if they have the same base. This base remains the same in the resulting answer. For example, \log 3(2) + \log
 equal to the product of the inputs given. Now log4(16) = 2 because 42 = 16. A logarithm simply asks what power of 2 to obtain 16 and so, the final answer of this question is just 2. The product rule for logarithms can also be written in reverse using
the formula: The product rule of logarithm laws The product rule of logarithm laws The product rule of logarithms states that a single logarithm. For example, log(21) = log(3) + log(7). Here are some examples of how to add logarithms using the addition
\log \text{law}. QuestionSolutionlog(5) + \log(3) = \log(5 \times 3) = \log(15)\log(3) + \log(3) = \log(3) = \log(3) + \log(3) = \log(3)
example, \log(8) - \log(4) = \log(2), since 8 \div 4 = 2. The result is a single logarithms using the quotient law is given as: The quotient law of logarithms using the quotient law is given as: The quotient law of logarithms using the quotient law is given as: The properties are those being subtracted.
 first logarithm is divided by the input of the logarithm being subtracted. The result is a single logarithm with the same base. For example of subtracting logarithms using the quotient logarithm law. \log 5(100) - \log 3(100 \div 4) which equals
log5(25). log5(25) can be evaluated since 25 is a power of 5. 52 = 25 and so, log5(25) = 2. The quotient rule for logarithm states that a single logarithm can be written as a logarithm subtracted from another logarithm. For example
\log(2/5) = \log(2) - \log(5). \text{ Here are some examples of how to subtract logarithms using the subtraction log(30) - \log(3) = \log(3)\log(30) - \log(3) = \log(3)\log(3) 
y = log(x2/y) If there is a coefficient in front of a logarithm, the power law of logarithms states that the input to the power of this coefficient in front of a logarithms for example, 2log(3) = log(32) which equals log(9). The formula for the power law of logarithms is: The power law of logarithms For example, 2log(3) = log(32) which equals log(9). The formula for the power law of logarithms is: The power law of logarithms for example, 2log(3) = log(32) which equals log(9) = log(9) which equals log(9) 
 \log 2(103). This is because the coefficient of 3 immediately in front of the log can be moved so that it is acting as a power on the number inside the log. Now \log 2(103) = \log 2(1000). When the reciprocal of the input to a logarithm is taken, the result is equal to -1 multiplied by the logarithm of the original input. That is \log (1/b) = -\log(b). For example
 log(1/2) = -log(2). We can see that since then . We can use the power law of logarithm to a logarithm to ecome the coefficient of the input to a logarithm so that or more simply, . For example, . The formula for the eciprocal of the input to a logarithm law can be applied
 in the following circumstances. (since both sides of the equation equal zero) When the coefficient of a logarithm is equal to one half, the input inside the logarithm can be raised to the power of this half. Raising a value to the power of one half is equivalent to finding its square root. Therefore (1/2)\log_a(b) = \log_a(\sqrt{b}). For example, (1/2)\log_a(b) = \log_a(\sqrt{b}).
\log(\sqrt{16}) = \log(4). The formula for the a logarithm with a coefficient of one half is given as: Formula for a logarithm with a coefficient of one half, it is equivalent of finding the square root of 16. Therefore (1/2)\log(16) = \log(161/2).
 = \log(\sqrt{16}) = \log(4). In general, . And so, the formula for any fractional coefficient of a logarithm is: Formula for a fractional coefficient of a logarithm is equal to the base of the logarithm, the result is simply the value of the
exponent inside the logarithm. For example, log3(35) = 5. The formula for the inverse property of Logarithms is: The Inverse property of Logarithms Is equal to zero no matter what the base of
the logarithm is. That is, \log(1) = 0 for all values of 'a'. Some of the many examples include: \log(1) = 0, \log(1) = 0, \log(1) = 0, and \ln(1) = 0. This rule is true since the value of the logarithm must be raised to in order to obtain the value of the input of the logarithm. Since
any positive or negative number raised to the power of zero is equal to 1 (that is, a0=1), then loga(1) must be equal to 0. The identity rule of logarithm, the result is equal to 1. That is, loga(a) = 1. For example, log3(3) = 1 and log2(2) = 1. This rule works since a
 logarithmic expression is equal in value to the power that its base must be raised to in order to obtain the value which is the input to the logarithms in the sense that \ln(e) = 1. This is because \ln(e) means \log(e). The inverse property of exponents
 states that if a given number is raised to the power of a logarithm which has the same base as this given number, then the result is simply equal to the input of the logarithms in the following manner: eln(k) = k. This is true since
ln(k) means loge(k). For example, eln(2) = 2. Here are some examples with solutions of using logarithm and there are no coefficients in
front of either logarithm. Therefore, it is important to always use the power logarithm laws to simplify. Both logarithms have coefficients and so, we use the power log law so that and. Therefore we know that and. Therefore
 becomes. Now that the coefficients have been moved and we simply have one logarithm, we can add them using the addition (product) law of logarithmic expression using logarithm laws. Simplify. We move the coefficients first
so that they become the powers of the inputs to the logarithm. In the first logarithm: and in the second logarithm: and in the same base, we can subtract them using the subtraction (quotient) law. We simply divide 8 by 2 to obtain 4. . Simplify . All logarithms are the same base and so we multiply the numbers
in the logarithms that are being added and then divide by the number inside the logarithm being subtracted. Therefore, and so, the answer is 5. ... Alternatively, we can use the addition (product) law
immediately so that. Then we can use the fact that 25=32 to evaluate. Evaluate . Evaluate . Evaluate in g(100) means 25=32 to evaluate log(100) means 25=32 to evaluate . Evaluate . Evaluate in g(100) means 25=32 to evaluate . Evaluate . Evaluate in g(100) means 25=32 to evaluate . Evaluate . Evaluate . Evaluate . Evaluate in g(100) means 25=32 to evaluate . E
logarithm, we can write. We can see that log5(25) = 2 since 52 = 25. Therefore . We can the logarithms to obtain: . Expand the logarithms to obtain: .
 bottom of the fraction are subtracted as we are dividing by this. We write . We can write \log 2(6) as \log 2(2) + \log 2(3). Therefore write \log 2(6) as \log 2(2) + \log 2(3). Therefore write \log 2(6) as \log 2(2) + \log 2(3). We can then write \log 2(6) as \log 2(2) + \log 2(3). Therefore write \log 2(6) as \log 2(2) + \log 2(3). Therefore write \log 2(6) as \log 2(2) + \log 2(3).
 bring down the power using the power law so that . Finally, we use the fact that \ln(e) = 1 so that: . Single logarithms can be expanded into multiple logarithms of the same base using logarithm laws. For example, using the addition (product) law, we can write \log(20) as \log(20) = \log(5) + \log(4). Then \log(4) can also be written as \log(22), which can be
 written as 2\log(2). Therefore \log(20) can be written as \log(20) = \log(5) + 2\log(2). Here is another example of expanding a logarithm laws, we can write a logarithm laws. Using the addition and subtracted since it has been
 divided inside the logarithm. We can then use the power law of logarithms to bring down the powers as coefficients. We can also evaluate log(10) = log(2). The change of base logarithm formula is: Th
 formula To divide logarithms that have the same base, the change of base formula can be used. That is, \log(27) = 3. The following is the algebraic proof of the product (addition) law of logarithms. Let and take logarithms of both sides to obtain
Then use the power law of logarithms to bring the power of m down as the coefficient of the logarithms to bring the (m+n) down as the coefficient of the
 log so that .Then expand the brackets to obtain .Finally substitute and from the previous calculations so that becomes . The following is the algebraic proof of the quotient (subtraction) law of logarithms to bring the power of m down as the coefficient of the
 logarithm. That is, .Take and follow the same process as above to obtain .Divide x by y so that and so, .Take logarithms of both sides so that .This can be written using the previous calculations so that becomes . The following is algebraic proof of the exponent (power)
 law of logarithms: Consider the expoenential equation of and write this in logarithmic form as . Now write in logarithmic form as . Now substitute as previously found into in order to obtain . This can be written in the more familiar format as . In this lesson
you'll be presented with the common rules of logarithms, and solving logarithms, and solving logarithms, condensing logarithms, and solving logarithms
exponent rules. Believe me, they always go hand in hand. If you're ever interested as to why the logarithm rules work, check out my lesson on proofs or justifications of logarithm rules work, check out the practice problems below to test your knowledge. Logarithm Rules Practice
Problems Rules of Logarithms Descriptions of Logarithm of the logarithm of
 number is the exponent times the logarithm of the base. Rule 4: Zero Rule The logarithm of [latex]1[/latex] to any base is always equal to zero. As long as [latex]b[/latex] is positive but [latex]b e 1[/latex] to any base is always equal to zero. As long as [latex]b[/latex] to any base is always equal to zero. As long as [latex]b[/latex] is positive but [latex]b e 1[/latex] to any base is always equal to zero. As long as [latex]b[/latex] is positive but [latex]b e 1[/latex] to any base is always equal to zero. As long as [latex]b[/latex] is positive but [latex]b e 1[/latex] to any base is always equal to zero. As long as [latex]b[/latex] is positive but [latex]b e 1[/latex] to any base is always equal to zero. As long as [latex]b[/latex] is positive but [latex]b e 1[/latex] is 
 for [latex]b>0[/latex]. Rule 6: Inverse Property of Logarithm The logarithm of an exponential number where its base is the same as the base of the log is equal to the number. Rule 8: Change of Base Formula Examples of How to Apply the Log
  Rules Example 1: Evaluate the expression below using Log Rules. [latex]{\log 2}8 + {\log 2}4[/latex] Express [latex]8[/latex] and [latex]4[/latex] and [latex]4[/latex] as exponential numbers with a base of [latex]4[/latex] express [latex]8[/latex] and [latex]4[/latex] expression below using Log Rules. [latex]4[/latex] express [latex]4[/latex]4[/latex]4[/latex]4[/latex]4[/latex]4[/latex]4[/latex]4[/latex]4[/latex]4[/latex]4[/latex]4[/latex]4[/latex]4[/latex]4[/latex]4[/latex]4[/latex]4[/latex]4[/latex]4[/latex]4[/latex]4[/latex]4[/latex]4[/latex]4[/latex]4[/latex]4[
[latex]\color{blue}5[/latex]. Example 2: Evaluate the expression below using Log Rules. [latex]4\log_3}162 - {\log_3}2[/latex] we can't express [latex]3[/latex]. It appears that we're stuck since there are no rules that can be applied in a direct manner. The Logarithm Rules can be used in reverse,
though! Observe that by using the Quotient Rule reversed, the log expression may be written as a single logarithmic number. We did it! By applying the rules in reverse, we generated a single logarithmic number. We did it! By applying the rules in reverse, we generated a single logarithmic number. We did it! By applying the rules in reverse, we generated a single logarithmic number. We did it! By applying the rules in reverse, we generated a single logarithmic number. We did it! By applying the rules in reverse, we generated a single logarithmic number. We did it! By applying the rules in reverse, we generated a single logarithmic number. We did it! By applying the rules in reverse, we generated a single logarithmic number. We did it! By applying the rules in reverse, we generated a single logarithmic number. We did it! By applying the rules in reverse, we generated a single logarithmic number. We did it! By applying the rules in reverse, we generated a single logarithmic number. We did it! By applying the rules in reverse, we generated a single logarithmic number. We did it! By applying the rules in reverse, we generated a single logarithmic number. We did it! By applying the rules in reverse, we generated a single logarithmic number.
things going on at the same time. First, see if you can simplify each of the logarithmic numbers. If not, start thinking about some of the obvious logarithmic rules that apply. By observation, we see that there are two bases involved: [latex]5[/latex] and [latex]4[/latex]. We can start this out by combining the terms that have the same base. Let's simplify
them separately. For log with base [latex]5[/latex], apply the Product Rule immediately. Then get the final answer by adding the two values found. Yep, the final answer is [latex]4[/latex], apply the Product Rule immediately. Then get the final answer by adding the two values found. Yep, the final answer is [latex]4[/latex], apply the Product Rule immediately. Then get the final answer by adding the two values found. Yep, the final answer is [latex]4[/latex], apply the Product Rule immediately. Then get the final answer by adding the two values found. Yep, the final answer is [latex]4[/latex], apply the Product Rule immediately. Then get the final answer by adding the two values found. Yep, the final answer is [latex]4[/latex], apply the Product Rule immediately. Then get the final answer by adding the two values found. Yep, the final answer is [latex]4[/latex], apply the Product Rule immediately. Then get the final answer by adding the two values found. Yep, the final answer is [latex]4[/latex], apply the Product Rule immediately. Then get the final answer by adding the two values found immediately.
 {\log 3}\left( {27{x^2}{y^5}} \right)[/latex] A product of factors is contained within the parenthesis. Apply the Product Rule to expressions into exact values whenever possible. Use Rule 5 (Identity rule) as much as possible because it can help to simplify the
 process. I must admit that the final answer appears "unfinished." But we shouldn't be concerned as long as we know we followed the rules correctly. Example 5: Expand the logarithmic expressions because they are in fractional form. Then utilize the Product Rule
to separate the product of factors as the sum of logarithmic expressions. Example 6: Expand the logarithmic expression in the denominator as [latex]{1 \over 2}}[/latex]. Express the radical denominator as [latex]{y^{{1 \over 2}}}[/latex]. Just like
problem #5, apply the Quotient Rule for logs and then use the Product Rule, Example 7: Expand the log rules properly in every step, there's nothing to
 worry about. You might notice that we need to apply the Quotient Rule first because the expression is in fractional form. Take a quiz: You might also like these tutorials: Tags: Advanced Algebra, Lessons Mathematical function, inverse of an exponential function Plots of logarithm functions, with three commonly used bases. The special points logb b
 1 are indicated by dotted lines, and all curves intersect in logb 1 = 0. Arithmetic operationsvte Addition (+) term + term summand + su
  {\text{wultiplication } \in \{\text{wiltiplication } 
  {\text{wultiplicand}}\end{matrix}}/\ product {\text{wultiplicand}} Division (÷) dividend divisor numerator denominator } = {\displaystyle \\scriptstyle {\text{divisor}}}}\\[1ex|\scriptstyle {\text{numerator}}}
  {\scriptstyle {\text{denominator}}}\end{matrix}\right,},=,,} { fraction quotient ratio {\displaystyle \scriptstyle {\text{fraction}}\end{matrix}}\right,} Exponentiation base exponent base power } = {\displaystyle \scriptstyle \left.}
  Logarithm (log) log base (anti-logarithm) = {\displaystyle \scriptstyle \log -{\text{base}}({\text{anti-logarithm}}}), =\, logarithm {\displaystyle \scriptstyle \logarithm}}} vte In mathematics, the logarithm {\displaystyle \scriptstyle \logarithm}}
of 1000 to base 10 is 3, because 1000 is 10 to the 3rd power: 1000 = 103 = 10 \times 10 \times 10. More generally, if x = by, then y is the logarithm of x to base b, written logb x, so log10 1000 = 3. As a single-variable function, the logarithm to base b is the inverse of exponentiation with base b. The logarithm base 10 is called the decimal or common logarithm.
and is commonly used in science and engineering. The natural logarithm has the number e ≈ 2.718 as its base; its use is widespread in mathematics and physics because of its very simple derivative. The binary logarithm uses base 2 and is widely used in computer science, information theory, music theory, and photography. When the base is
unambiguous from the context or irrelevant it is often omitted, and the logarithm is written log x. Logarithms were introduced by John Napier in 1614 as a means of simplifying calculations.[1] They were rapidly adopted by navigators, scientists, engineers, surveyors, and others to perform high-accuracy computations more easily. Using logarithm
tables, tedious multi-digit multiplication steps can be replaced by table look-ups and simpler addition. This is possible because the logarithm of a product is the sum of the logarithm of a product is the sum of the logarithm of a product is the sum of the logarithm of a product is the sum of the logarithm of a product is the sum of the logarithm of a product is the sum of the logarithm of a product is the sum of the logarithm of a product is the sum of the logarithm of a product is the sum of the logarithm of a product is the sum of the logarithm of a product is the sum of the logarithm of a product is the sum of the logarithm of a product is the sum of the logarithm of a product is the sum of the logarithm of a product is the sum of the logarithm of a product is the sum of the logarithm of a product is the sum of the logarithm of a product is the sum of the logarithm of a product is the sum of the logarithm of a product is the sum of the logarithm of a product is the sum of the logarithm of a product is the sum of the logarithm of a product is the sum of the logarithm of a product is the sum of the logarithm of a product is the sum of the logarithm of a product is the sum of the logarithm of a product is the sum of the logarithm of a product is the sum of the logarithm of a product is the sum of the logarithm of a product is the sum of the logarithm of a product is the sum of the logarithm of a product is the sum of the logarithm of a product is the sum of the logarithm of a product is the sum of the logarithm.
also based on logarithms, allows quick calculations without tables, but at lower precision. The present-day notion of logarithms comes from Leonhard Euler, who connected them to the exponential function in the 18th century, and who also introduced the letter e as the base of natural logarithms. [2] Logarithms comes from Leonhard Euler, who connected them to the exponential function in the 18th century, and who also introduced the letter e as the base of natural logarithms.
to smaller scopes. For example, the decibel (dB) is a unit used to express ratio as logarithms, mostly for signal power and amplitude (of which sound pressure is a common example). In chemistry, pH is a logarithms are common place in scientific formulae, and in measurements of the
complexity of algorithms and of geometric objects called fractals. They help to describe frequency ratios of musical intervals, appear in formulas counting prime numbers or approximating factorials, inform some models in psychophysics, and can aid in forensic accounting. The concept of logarithm as the inverse of exponentiation extends to other
mathematical structures as well. However, in general settings, the logarithm tends to be a multi-valued function. For example, the complex logarithm is the multi-valued inverse of the exponential function in finite groups; it has uses in public-key
cryptography. The graph of the logarithm base 2 crosses the x-axis at x = 1 and passes through the points (2, 1), (4, 2), and (8, 3), depicting, e.g., \log 2(8) = 3 and 23 = 8. The graph gets arbitrarily close to the y-axis, but does not meet it. Addition, multiplication, and exponentiation are three of the most fundamental arithmetic operations. The inverse
of addition is subtraction, and the inverse of multiplication is division. Similarly, a logarithm is the inverse operation of exponentiation. Exponentiation is when a number b, the base, is raised to a certain power y, the exponentiation is division. Similarly, a logarithm is the inverse operation of exponentiation is division. Similarly, a logarithm is the inverse operation of exponentiation is division. Similarly, a logarithm is the inverse operation of exponentiation is division.
 \{\text{displaystyle } 2^{3}=8.\} The logarithm of base b is the inverse operation, that provides the output y from the input x. That is, y = \log b \times \{\text{displaystyle } x=b^{y}\} if b is a positive real number. (If b is not a positive real number, both exponentiation and logarithm can be defined but may take
 several values, which makes definitions much more complicated.) One of the main historical motivations of introducing logarithms is the formula log b (x y) = \log b x + \log b y, (x y) = \log b x + \log b y, (x y) = \log b x + \log b y, (x y) = \log b x + \log b y, (x y) = \log b x + \log b y, (x y) = \log b x + \log b y, (x y) = \log b x + \log b y, (x y) = \log b x + \log b y, (x y) = \log b x + \log b y, (x y) = \log b x + \log b y, (x y) = \log b x + \log b y, (x y) = \log b x + \log b y, (x y) = \log b x + \log b y, (x y) = \log b x + \log b y, (x y) = \log b x + \log b y, (x y) = \log b x + \log b y, (x y) = \log b x + \log b y, (x y) = \log b x + \log b y, (x y) = \log b x + \log b y, (x y) = \log b x + \log b y, (x y) = \log b x + \log b y, (x y) = \log b x + \log b y, (x y) = \log b x + \log b y, (x y) = \log b x + \log b y, (x y) = \log b x + \log b y, (x y) = \log b x + \log b y, (x y) = \log b x + \log b y, (x y) = \log b x + \log b y, (x y) = \log b x + \log b y, (x y) = \log b x + \log b y, (x y) = \log b x + \log b y, (x y) = \log b x + \log b y, (x y) = \log b x + \log b y, (x y) = \log b x + \log b y, (x y) = \log b x + \log b y, (x y) = \log b x + \log b y, (x y) = \log b x + \log b y, (x y) = \log b x + \log b y, (x y) = \log b x + \log b y, (x y) = \log b x + \log b y, (x y) = \log b x + \log b y, (x y) = \log b x + \log b y, (x y) = \log b x + \log b y, (x y) = \log b x + \log b y, (x y) = \log b x + \log b y, (x y) = \log b x + \log b y, (x y) = \log b x + \log b y, (x y) = \log b x + \log b x, (x y) = \log b x + \log b x, (x y) = \log b x, (x y) 
calculations before the invention of computers. Given a positive real number y such that b \neq 1, the logarithm of x to base b [nb 1] is the exponent by which b must be raised to yield x. In other words, the logarithm of x to base b [nb 1] is the exponent by which b must be raised to yield x. In other words, the logarithm of x to base b [nb 1] is the exponent by which b must be raised to yield x. In other words, the logarithm of x to base b [nb 1] is the exponent by which b must be raised to yield x. In other words, the logarithm of x to base b [nb 1] is the exponent by which b must be raised to yield x. In other words, the logarithm of x to base b [nb 1] is the exponent by which b must be raised to yield x. In other words, the logarithm of x to base b [nb 1] is the exponent by which b must be raised to yield x. In other words, the logarithm of x to base b [nb 1] is the exponent by which b must be raised to yield x. In other words, the logarithm of x to base b [nb 1] is the exponent by which b must be raised to yield x. In other words, the logarithm of x to base b [nb 1] is the exponent by which b must be raised to yield x. In other words, the logarithm of x to base b [nb 1] is the exponent by which b must be raised to yield x. In other words, the logarithm of x to base b [nb 1] is the exponent by which b must be raised to yield x. In other words, the logarithm of x to base b [nb 1] is the exponent by which b must be raised to yield x. In other words, the logarithm of x to base b [nb 1] is the exponent by which b must be raised to yield x. In other words, the logarithm of x to base b [nb 1] is the exponent by which b must be raised to yield x. In other words, the logarithm of x to base b [nb 1] is the exponent by which b must be raised to yield x. In other words, the logarithm of x to base b [nb 1] is the exponent by which b must be raised to yield x. In other words, the logarithm of x to base b [nb 1] is the exponent by which b [nb 1] is the exponent by which by [nb 1] is the exponent by which by [nb 1] is th
is denoted "logb x" (pronounced as "the logarithm of x to base b", "the base-b logarithm of x", or most commonly "the log, base b, of x"). An equivalent and more succinct definition is that the function to the function to the function to the function x \mapsto b \times x (displaystyle x\mapsto b^{x}). In equivalent and more succinct definition is that the function x \mapsto b \times x (as x \mapsto b \times x).
negative: \log 2 1 2 = -1 {\textstyle \log \{2\}\!\frac \{1\}\{2\}\}=-1} since 2 - 1 = 1 2 1 = 1 2 1 = 1 2 1 = 1 2 1 = 1 2 1 = 1 2 1 = 1 2 1 = 1 2 1 = 1 2 1 = 1 2 1 = 1 2 1 = 1 2 1 = 1 2 1 = 1 2 1 = 1 2 1 = 1 2 1 = 1 2 1 = 1 2 1 = 1 2 1 = 1 2 1 = 1 2 1 = 1 2 1 = 1 2 1 = 1 2 1 = 1 2 1 = 1 2 1 = 1 2 1 = 1 2 1 = 1 2 1 = 1 2 1 = 1 2 1 = 1 2 1 = 1 2 1 = 1 2 1 = 1 2 1 = 1 2 1 = 1 2 1 = 1 2 1 = 1 2 1 = 1 2 1 = 1 2 1 = 1 2 1 = 1 2 1 = 1 2 1 = 1 2 1 = 1 2 1 = 1 2 1 = 1 2 1 = 1 2 1 = 1 2 1 = 1 2 1 = 1 2 1 = 1 2 1 = 1 2 1 = 1 2 1 = 1 2 1 = 1 2 1 = 1 2 1 = 1 2 1 = 1 2 1 = 1 2 1 = 1 2 1 = 1 2 1 = 1 2 1 = 1 2 1 = 1 2 1 = 1 2 1 = 1 2 1 = 1 2 1 = 1 2 1 = 1 2 1 = 1 2 1 = 1 2 1 = 1 2 1 = 1 2 1 = 1 2 1 = 1 2 1 = 1 2 1 = 1 2 1 = 1 2 1 = 1 2 1 = 1 2 1 = 1 2 1 = 1 2 1 = 1 2 1 = 1 2 1 = 1 2 1 = 1 2 1 = 1 2 1 = 1 2 1 = 1 2 1 = 1 2 1 = 1 2 1 = 1 2 1 = 1 2 1 = 1 2 1 = 1 2 1 = 1 2 1 = 1 2 1 = 1 2 1 = 1 2 1 = 1 2 1 = 1 2 1 = 1 2 1 = 1 2 1 = 1 2 1 = 1 2 1 = 1 2 1 = 1 2 1 = 1 2 1 = 1 2 1 = 1 2 1 = 1 2 1 = 1 2 1 = 1 2 1 = 1 2 1 = 1 2 1 = 1 2 1 = 1 2 1 = 1 2 1 = 1 2 1 = 1 2 1 = 1 2 1 = 1 2 1 = 1 2 1 = 1 2 1 = 1 2 1 = 1 2 1 = 1 2 1 = 1 2 1 = 1 2 1 = 1 2 1 = 1 2 1 = 1 2 1 = 1 2 1 = 1 2 1 = 1 2 1 = 1 2 1 = 1 2 1 = 1 2 1 = 1 2 1 = 1 2 1 = 1 2 1 = 1 2 1 = 1 2 1 = 1 2 1 = 1 2 1 = 1 2 1 = 1 2 1 = 1 2 1 = 1 2 1 = 1 2 1 = 1 2 1 = 1 2 1 = 1 2 1 = 1 2 1 = 1 2 1 = 1 2 1 = 1 2 1 = 1 2 1 = 1 2 1 = 1 2 1 = 1 2 1 = 1 2 1 = 1 2 1 = 1 2 1 = 1 2 1 = 1 2 1 = 1 2 1 = 1 2 1 = 1 2 1 = 1 2 1 = 1 2 1 = 1 2 1 = 1 2 1 = 1 2 1 = 1 2 1 = 1 2 1 = 1 2 1 = 1 2 1 = 1 2 1 = 1 2 1 = 1 2 1 = 1 2 1 = 1 2 1 = 1 2 1 = 1 2 1 = 1 2 1 = 1 2 1 = 1 2 1 = 1 2 1 = 1 2 1 = 1 2 1 = 1 2 1 = 1 2 1 = 1 2 1 = 1 2 1 = 1 2 1 = 1 2 1 = 1 2 1 = 1 2 1 = 1 2 1 = 1 2 1 = 1 2 1 = 1 2 1 = 1 2 1 = 1 2 1 = 1 2 1 = 1 2 1 = 1 2 1 = 1 2 1 = 1 2 1 = 1 2 1 = 1 2 1 = 1 2 1 = 1 2 1 = 1 2 1 = 1 2 1 = 1 2 1 = 1 2 1 = 1 2 1 = 1 2 1 = 1 2 1 = 1 2 1 = 1 2 1 = 1 2 1 = 1 2 1 = 1 2 1 = 1 2 1 = 1 2 1 = 1 2 1 = 1 2 1 = 1 2 1 = 1 2 1 = 1 2 1 = 1 2 1 = 1 2 1 = 1 2 1 = 1 2 1 = 1 2 1 = 1 2 1 = 1 2 1 = 1 2 1 = 1 2 1 = 1 2 1 = 1
Main article: List of logarithmic identities Several important formulas, sometimes called logarithms of the logarithms. The logarithms of the logarithms.
the p-th power of a number is p times the logarithm of the number itself; the logarithm of the number divided by p. The following table lists these identities with examples. Each of the identities can be derived after substitution of the logarithm of the number itself; the number itself; the logarithm of the number itself; th
 \{\text{displaystyle y=b^{{,\log {b}y}}}\}\ in the left hand sides. In the following formulas, x \{\text{displaystyle x}\}\ and y \{\text{displaystyle y}\}\ are positive real numbers and p \{\text{displaystyle y}\}\ in the left hand sides. In the following formulas, x \{\text{displaystyle y}\}\ are positive real numbers and p \{\text{displaystyle y}\}\ are positive real numbers and p \{\text{displaystyle y}\}\ in the left hand sides. In the following formulas, p \{\text{displaystyle y}\}\ are positive real numbers and p \{\text{displaysty
  \{b\}(xy) = \log_{b}x + \log_{b}y\} \log 3 \ 243 = \log 3 \ (9 \cdot 27) = \log 3 \ 9 + \log 3 \ 27 = 2 + 3 = 5 \ (9 \cdot 27) = \log 3 \ 9 + \log 3 \ 27 = 2 + 3 = 5 \ (23) = \log 64 - \log 2 \ 4 = 6 - 2 = 4 \ (23) = \log 64 - \log 2 \ 4 = 6 - 2 = 4 \ (23) = \log 64 - \log 64 
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   \{k\}x\}\{\log \{k\}b\}\}.\} Typical scientific calculators calculate the logarithms by the previous formula: \log b = \log 10 \times \log 10 = \log 10 = \log 10 \times \log 10 =
  \{\log_{e}b\}.\} Given a number x and its logarithm y = logb x to an unknown base b, the base is given by: b = x 1 y, \{\dim x = b \mid y \mid x = b \mid x = b \mid y \mid x = b \mid x =
 logarithm for bases 1/2, 2, and e Among all choices for the base, three are particularly common. These are b = 10, b = e (the binary logarithm base e is widespread because of analytical properties explained below. On the other hand, base 10
logarithms (the common logarithm) are easy to use for manual calculations in the decimal number system: [6] \log 10 \ (10 \ x) = \log 10 \ x. {\displaystyle \log_{10} \x\...} Thus, log 10 \x\...} Thus, log 10 \x\...} Thus, log 10 \x\....
number of digits is the smallest integer strictly bigger than log10 (x). [7] For example, log10(5986) is approximately 3.78. The next integer above it is 4, which is the number of digits of 5986. Both the natural logarithm and the binary logarithm are used in information theory, corresponding to the use of nats or bits as the fundamental units of
information, respectively.[8] Binary logarithms are also used in computer science, where the binary system is ubiquitous; in music theory, where a pitch ratio of two (the octave) is ubiquitous; in music theory, where a pitch ratio of two (the octave) is ubiquitous; in music theory, where a pitch ratio of two (the octave) is ubiquitous; in music theory, where a pitch ratio of two (the octave) is ubiquitous; in music theory, where a pitch ratio of two (the octave) is ubiquitous; in music theory, where a pitch ratio of two (the octave) is ubiquitous; in music theory, where a pitch ratio of two (the octave) is ubiquitous; in music theory, where a pitch ratio of two (the octave) is ubiquitous; in music theory, where a pitch ratio of two (the octave) is ubiquitous; in music theory, where a pitch ratio of two (the octave) is ubiquitous; in music theory, where a pitch ratio of two (the octave) is ubiquitous; in music theory, where a pitch ratio of two (the octave) is ubiquitous; in music theory, where a pitch ratio of two (the octave) is ubiquitous; in music theory, where a pitch ratio of two (the octave) is ubiquitous; in music theory, where a pitch ratio of two (the octave) is ubiquitous; in music theory, where a pitch ratio of two (the octave) is ubiquitous; in music theory, where a pitch ratio of two (the octave) is ubiquitous; in music theory, where a pitch ratio of two (the octave) is ubiquitous; in music theory, where a pitch ratio of two (the octave) is ubiquitous; in music theory, where a pitch ratio of two (the octave) is ubiquitous; in music theory, where a pitch ratio of two (the octave) is ubiquitous; in music theory, where a pitch ratio of two (the octave) is ubiquitous; in music theory, where a pitch ratio of two (the octave) is ubiquitous; in music theory, where a pitch ratio of two (the octave) is ubiquitous; in music theory, where a pitch ratio of two (the octave) is ubiquitous; in music theory, where a pitch ratio of two (the octave) is ubiquitous; in music theory, where a pitch ratio of two (the oct
semitone in conventional equal temperament), or equivalently the log base 21/1200; and in photography rescaled base 2 logarithms are used to measure exposure times, lens apertures, and film speeds in "stops".[9] The abbreviation log x is often used when the intended base can be inferred based on the context or
discipline, or when the base is indeterminate or immaterial. Common logarithms (base 10), historically used in logarithm tables and engineering; in these contexts log x still often means the base ten logarithm. [10] In mathematics log x usually refers to the
natural logarithm (base e).[11] In computer science and information theory, log often refers to binary logarithms (base 2).[12] The following table lists common notations for logarithms to these bases. The "ISO notation" column lists designations suggested by the International Organization for Standardization.[13] Base b Name for logarithms to these bases.
Other notations 2 binary logarithm lb x [14] ld x, log x, lg x, lg x, lg x, log 2 x e natural logarithm ln x [nb 3] log x, loge x 10 common logarithms in seventeenth-century Europe saw the discovery of a new function that extended the realm of analysis
beyond the scope of algebraic methods. The method of logarithms was publicly propounded by John Napier in 1614, in a book titled Mirifici Logarithms of the Wonderful Canon of Logarithms was publicly propounded by John Napier in 1614, in a book titled Mirifici Logarithms was publicly propounded by John Napier in 1614, in a book titled Mirifici Logarithms was publicly propounded by John Napier in 1614, in a book titled Mirifici Logarithms was publicly propounded by John Napier in 1614, in a book titled Mirifici Logarithms was publicly propounded by John Napier in 1614, in a book titled Mirifici Logarithms was publicly propounded by John Napier in 1614, in a book titled Mirifici Logarithms was publicly propounded by John Napier in 1614, in a book titled Mirifici Logarithms was publicly propounded by John Napier in 1614, in a book titled Mirifici Logarithms was publicly propounded by John Napier in 1614, in a book titled Mirifici Logarithms was publicly propounded by John Napier in 1614, in a book titled Mirifici Logarithms was publicly propounded by John Napier in 1614, in a book titled Mirifici Logarithms was publicly propounded by John Napier in 1614, in a book titled Mirifici Logarithms was publicly propounded by John Napier in 1614, in a book titled Mirifici Logarithms was publicly propounded by John Napier in 1614, in a book titled Mirifici Logarithms was publicly propounded by John Napier in 1614, in a book titled Mirifici Logarithms was publicly propounded by John Napier in 1614, in a book titled Mirifici Logarithms was publicly propounded by John Napier in 1614, in a book titled Mirifici Logarithms was publicly propounded by John Napier in 1614, in a book titled Mirifici Logarithms was publicly propounded by John Napier in 1614, in a book titled Mirifici Logarithms was publicly propounded by John Napier in 1614, in a book titled Mirifici Logarithms was publicly propounded by John Napier in 1614, in a book titled Mirifici Logarithms was publicly propounded by John Napier in 1614, in a book titled Mirifici L
use of tables of progressions, extensively developed by Jost Bürgi around 1600.[21][22] Napier coined the term for logarithm in Middle Latin, logarithm of a number', derived from the Greek logos 'proportion, ratio, word' + arithmos 'number'. The common logarithm of a number is the index of that power of ten which equals the
number.[23] Speaking of a number as requiring so many figures is a rough allusion to common logarithm, and was referred to by Archimedes as the "order of a number".[24] The first real logarithms were heuristic methods to turn multiplication into addition, thus facilitating rapid computation. Some of these methods used tables derived from
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trigonometric identities.[25] Such methods are called prosthaphaeresis. Invention of the function now known as the natural logarithm began as an attempt to perform a quadrature of a rectangular hyperbola by Grégoire de Saint-Vincent, a Belgian Jesuit residing in Prague. Archimedes had written The Quadrature of the Parabola in the third century

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BC, but a quadrature for the hyperbola eluded all efforts until Saint-Vincent published his results in 1647. The relation that the logarithm provides between a geometric progression in its argument and an arithmetic progression of values, prompted A. A. de Sarasa to make the connection of Saint-Vincent's quadrature and the tradition of logarithms in
 prosthaphaeresis, leading to the term "hyperbolic logarithm", a synonym for natural logarithm. Soon the new function was appreciated by Christiaan Huygens, and James Gregory. The notation Log y was adopted by Gottfried Wilhelm Leibniz in 1675,[26] and the next year he connected it to the integral f d y y . {\textstyle \int {\frac {dy}{y}}.} Before
 Euler developed his modern conception of complex natural logarithms, Roger Cotes had a nearly equivalent result when he showed in 1714 that [27] log (cos \theta + i sin \theta) = i \theta. {\displaystyle \log(\cos \theta +i\sin \theta) = i \theta. {\displaystyle \log(\cos \theta) = i \theta. }
and computers became available, logarithms contributed to the advance of science, especially astronomy. They were critical to advances in surveying, celestial navigation, and other domains. Pierre-Simon Laplace called logarithms ... [a]n admirable artifice which, by reducing to a few days the labour of many months, doubles the life of the
 astronomer, and spares him the errors and disgust inseparable from long calculations. [28] As the function of logb x, it has been called an exponential function. A key tool that enabled the practical use of logarithms was the table of logarithms. [30]
The first such table was compiled by Henry Briggs in 1617, immediately after Napier's invention but with the innovation of using 10 as the base. Briggs' first table contained the common logarithms of all integers in the range from 1 to 1000, with a precision of 14 digits. Subsequently, tables with increasing scope were written. These tables listed the
 values of log10 x for any number x in a certain range, at a certain precision. Base-10 logarithms were universally used for computation, hence the name common logarithm of x can be separated into an integer part and a fractional part, known as
the characteristic and mantissa. Tables of logarithms need only include the mantissa, as the characteristic of x, and their mantissas are the same. Thus using a three-digit log table, the logarithm of 3542 is approximated by
log 10 3542 = log 10 (1000 \cdot 3.542) = 3 + log 10 (1000 \cdot 3.542) = 3 + log 10 3.542 + log 10 3.
 {\displaystyle \log \{10\}3.54+0.2(\log \{10\}3.55+\log \{10\}
 product cd or quotient c/d came from looking up the antilogarithm of the sum or difference, via the same table: c d = 10 log 10 c + log 10 d = 10 log 10 c + log 10 d = 10 log 10 c - log 10 d - log 10 c - log 10 d . {\displaystyle {\frac {c}}}
 {d}}=cd^{-1}=10^{\\log_{10}c\,-\\log_{10}c\,-\\log_{10}d}.} For manual calculations that demand any appreciable precision, performing the lookups of the two logarithms, calculating their sum or difference, and looking up the antilogarithm is much faster than performing the multiplication by earlier methods such as prosthaphaeresis, which relies on
 trigonometric identities. Calculations of powers and roots are reduced to multiplications or divisions and lookups by c d = (10 log 10 c \\displaystyle c^{d}=\left(10^{\\log 10 c \\displaystyle (\frac {1}{d})}=c^{\\frac {1}{d}}=10^{\\log 10 c \\displaystyle c^{\displaystyle (\frac {1}{d})}=10^{\\log 10 c \\displaystyle c^{\displaystyle c^{\digned c^{\displaystyle c^{\displaystyle c^{\digned c^{\displaystyle c^
 _{10}c}.} Trigonometric calculations were facilitated by tables that contained the common logarithms of trigonometric functions. Main article: Slide rule Another critical application was the slide rule, a pair of logarithmic after Napier's
 invention. William Oughtred enhanced it to create the slide rule—a pair of logarithms, as illustrated here: Schematic
 depiction of a slide rule. Starting from 2 on the lower scale, add the distance from 1 to x is proportional to the logarithm of x. For example, adding the distance from 1 to 2 on the lower scale to the distance from 1 to 3 on the upper scale
yields a product of 6, which is read off at the lower part. The slide rule was an essential calculating tool for engineers and scientists until the 1970s, because it allows, at the expense of precision, much faster computation than techniques based on tables.[32] A deeper study of logarithms requires the concept of a function. A function is a rule that,
given one number, produces another number. [33] An example is the function producing the x-th power of b from any real number x, where the base b is a fixed number as f(x) = b x. When b is positive reals. Let b be
a positive real number not equal to 1 and let f(x) = bx. It is a standard result in real analysis that any continuous, has domain and range. This fact follows from the intermediate value theorem. [34] Now, f is strictly increasing (for 0 < b < 1), [35] is continuous, has domain Figure 1.
  \{\text{displaystyle } R\} \}, and has range R>0 \{\text{R} _{<>0}\}. In other words, for each positive real number y, there is exactly one real number x such that b x=y \{\text{displaystyle } R\} _{<>0}\}. We let \log b: R>0 \to R
  \{ \text{b} \ \{b\} \ \{b\} \ \{n\} \ \{
 formula log b (xy) = \log b x + \log b y. {\displaystyle \log _{b}x+\log _{b}y.} More precisely, the logarithm to any base b > 1 is the only increasing function f from the positive reals to the reals satisfying f(b) = 1 and[36] f (xy) = f(x) + f(y). {\displaystyle f(xy)=f(x)+f(y).} The graph of the logarithm function logb (x) (blue) is
obtained by reflecting the graph of the function bx (red) at the diagonal line (x = y). As discussed above, the function bx (red) at the diagonal line x = y), as
 shown at the right: a point (t, u = bt) on the graph of f yields a point (u, t = logb u) on the graph of the logarithm and vice versa. As a consequence, logb (x) diverges to infinity (gets bigger than any given number) if x grows to infinity, provided that b is greater than one. In that case, logb(x) is an increasing function. For b < 1, logb (x) tends to minus
 infinity instead. When x approaches zero, logb x goes to minus infinity for b > 1 (plus infinity for b < 1, respectively). The graph of the natural logarithm (green) and its tangent at x = 1.5 (black) Analytic properties of functions pass to their inverses. [34] Thus, as f(x) = bx is a continuous and differentiable function, so is logb y. Roughly, a continuous
 function is differentiable if its graph has no sharp "corners". Moreover, as the derivative of f(x) evaluates to h(b) by the properties of the exponential function, the chain rule implies that the derivative of f(x) evaluates to h(b) by the properties of the exponential function, the chain rule implies that the derivative of h(x) evaluates to h(b) by the properties of the exponential function, the chain rule implies that the derivative of h(x) evaluates to h(b) by the properties of the exponential function, the chain rule implies that the derivative of h(x) evaluates to h(b) by the properties of the exponential function, the chain rule implies that the derivative of h(x) evaluates to h(b) by the properties of h(a) evaluates h(a) function h(a) evaluates h(a) eval
tangent touching the graph of the base-b logarithm; this is also one of the main reasons of the importance to qualify as "natural" the natural logarithm; this is also one of the main reasons of the importance to qualify as "natural" the natural logarithm; this is also one of the main reasons of the importance to qualify as "natural" the natural logarithm; this is also one of the main reasons of the importance to qualify as "natural" the natural logarithm; this is also one of the main reasons of the importance to qualify as "natural" the natural logarithm; this is also one of the main reasons of the importance to qualify as "natural" the natural logarithm; this is also one of the main reasons of the importance to qualify as "natural" the natural logarithm; this is also one of the main reasons of the importance to qualify as "natural" the natural logarithm; this is also one of the main reasons of the importance to qualify as "natural" the natural logarithm; this is also one of the main reasons of the importance to qualify as "natural" the natural logarithm; this is also one of the main reasons of the importance to qualify as "natural" the natural logarithm at the point (x, logb (x)) and (x) are the natural logarithm at the point (x, logb (x)) are the natural logarithm.
of the constant e. The derivative with a generalized functional argument f(x) is d d x ln f(x) = f'(x) f(x). The quotient at the right hand side is called the logarithmic derivative of f. Computing f'(x) by means of the derivative of h(f(x)) is known as logarithmic differentiation. [38] The
antiderivative of the natural logarithm ln(x) is:[39] \int ln (x) dx = x ln (x) - x + C. {\displaystyle \int \ln(x)\,dx=x\ln(x)-x+C.} Related formulas, such as antiderivatives of logarithms to other bases can be derived from this equation using the change of bases.[40] The natural logarithm of t is the shaded area underneath the graph of the function f(x) =
1/x. The natural logarithm of t can be definite integral: t = \int 1 t 1 x d x. {\displaystyle \ln t=\int_{1}^{t}}\,dx.} This definition is in terms of an integral of a simple reciprocal. As an integral, t = \int 1 t 1 x d x.
area between the x-axis and the graph of the function 1/x, ranging from x = 1 to x = t. This is a consequence of the fundamental theorem of calculus and the fact that the derivative of \ln(x) is 1/x. Product and power logarithm formulas can be derived from this definition. [41] For example, the product formula \ln(tu) = \ln(t) + \ln(u) is deduced as: \ln(tu) = \ln(t) + \ln(u) is deduced as: \ln(tu) = \ln(t) + \ln(u) is definition.
 = \int 1 t u 1 x d x = (1) \int 1 t 1 x d x + \int t t u 1 x d x + \int t t u 1 x d x + \int t t u 1 x d x + \int t t u 1 x d x + \int t t u 1 x d x + \int t t u 1 x d x + \int t t u 1 x d x + \int t t u 1 x d x + \int t t u 1 x d x + \int t t u 1 x d x + \int t t u 1 x d x + \int t t u 1 x d x + \int t t u 1 x d x + \int t t u 1 x d x + \int t t u 1 x d x + \int t t u 1 x d x + \int t t u 1 x d x + \int t t u 1 x d x + \int t t u 1 x d x + \int t t u 1 x d x + \int t t u 1 x d x + \int t t u 1 x d x + \int t t u 1 x d x + \int t t u 1 x d x + \int t t u 1 x d x + \int t t u 1 x d x + \int t t u 1 x d x + \int t t u 1 x d x + \int t t u 1 x d x + \int t t u 1 x d x + \int t t u 1 x d x + \int t t u 1 x d x + \int t t u 1 x d x + \int t t u 1 x d x + \int t t u 1 x d x + \int t t u 1 x d x + \int t t u 1 x d x + \int t t u 1 x d x + \int t t u 1 x d x + \int t t u 1 x d x + \int t t u 1 x d x + \int t t u 1 x d x + \int t t u 1 x d x + \int t t u 1 x d x + \int t t u 1 x d x + \int t u 1 x 
 \{w\}, \&=\ln(t)+\ln(u). (a) splits the equality (1) splits the integral into two parts, while the equality (2) is a change of variable (w=x/t). In the illustration below, the splitting corresponds to dividing the area into the yellow and blue parts. Rescaling the left hand blue area vertically by the factor t and shrinking it by the same factor
 horizontally does not change its size. Moving it appropriately, the area fits the graph of the function f(x) = 1/x again. Therefore, the left hand blue area, which is the integral of f(x) from t to tu is the same as the integral from 1 to u. This justifies the equality (2) with a more geometric proof. A visual proof of the product formula of the natural logarithm
The power formula \ln(tr) = r \ln(t) may be derived in a similar way: \ln(tr) = \int 1 t r 1 x d x = \int 1 t 1 w r (r w r - 1 d w) = r \int 1 t 1 w d w = r \ln(t). {\displaystyle {\begin{aligned}\\n(t^{r})}{\chick}=\\n(t) \. {\displaystyle {\begin{aligned}\\n(t) \chick}=\\n(t) \. {\displaystyle {\begin{aligned}\\n(t) \\n(t) \n(t) \\n(t) \\n(t) \\n(t) \\n(t) \\n(t) \\n(t) \\n(t) \\n(t) \\n(
 \{w\}\down{c}=r\ln(t).end\{aligned\}\}\ The second equality uses a change of variables (integration by substitution), w=x1/r. The sum over the reciprocals of natural numbers, 1+12+13+\cdots+1 n = \sum k=1 n 1 k, \{h\}, is called the harmonic function of the properties of the natural numbers.
 series. It is closely tied to the natural logarithm: as n tends to infinity, the difference, \sum k = 1 n 1 k - \ln (n), \{ \ln (n), \} converges (i.e. gets arbitrarily close) to a number known as the Euler-Mascheroni constant \gamma = 0.5772... This relation aids in analyzing the performance of algorithms such as quicksort
[42] Real numbers that are not algebraic are called transcendental; [43] for example, I and e are such numbers, but 2 - 3 {\displaystyle {\sqrt {2-{\sqrt {3}}}}} is not. Almost all real numbers are transcendental function. The Gelfond-Schneider theorem asserts that logarithms usually take
 transcendental, i.e. "difficult" values.[44] The logarithm keys (LOG for base 10 and LN for base e) on a TI-83 Plus graphing calculated using power series or the arithmetic-geometric mean, or be retrieved from a precalculated logarithm
table that provides a fixed precision. [45][46] Newton's method, an iterative method to solve equations approximately, can be used to calculate the logarithm, because its inverse function, the exponential function, can be used to calculate the logarithm by using only the
operations of addition and bit shifts.[48][49] Moreover, the binary logarithm algorithm algorit
 approximations along with the 99th and 100th. The approximations do not converge beyond a distance of 1 from the center. For any real number z that satisfies 0 < z \le 2, the following formula holds:[nb 4][50] ln (z) = (z-1)22 + (z-1)33 - (z-1)44 + \cdots = \sum k = 1 ∞ (-1)k + 1(z-1)k (\displaystyle
 \{\begin{aligned}\ln(z)&=\{\frac {(z-1)^{1}}_{1}}_{\{\frac {(z-1)^{2}}_{2}}+\{\frac {(z-1)^{2}}_{1}}_{\{\frac {(z-1)^{2}}_{2}}+\{\frac {(z-1)^{2}}_{1}}_{\{\frac {(z-1)^{2}}_{1}}}\} Equating the function \ln(z) to this infinite sum (series) is shorthand for saying that the function can be approximated to a more and more
 accurate value by the following expressions (known as partial sums): (z-1) - (z-1) 2 + (z-1) - (z-1) - (z-1) 2 + (z-1) - (z-
0.011 greater than \ln(1.5) = 0.405465, and the ninth approximation yields 0.40553, which is only about 0.0001 greater. The nth partial sum can approximate \ln(z) with arbitrary precision, provided the number of summands n is large enough. In elementary calculus, the series is said to converge to the function \ln(z), and the function is the limit of the
series. It is the Taylor series of the natural logarithm at z = 1. The Taylor series of \ln(z) provides a particularly useful approximation to \ln(1+z) = z - z \cdot 2 \cdot 2 + z \cdot 3 \cdot 3 - \cdots \approx z. {\displaystyle \\ln(1+z)=z-{\\frac \{z^{2}\}\{2\}\}+{\\frac \{z^{2}\}\}\{3\}\}-\\cdots \\approx z.\} For example, with z = 0.1 the first-order
approximation gives \ln(1.1) \approx 0.1, which is less than 5% off the correct value 0.0953. Another series is based on the inverse hyperbolic tangent function: \ln(z) = 2 \cdot \arctan z + 1 \cdot 3 \cdot z - 1 \cdot z + 1 \cdot 3 \cdot z - 1 \cdot z + 1 \cdot 3 \cdot z - 1 \cdot z + 1 \cdot 3 \cdot z - 1 \cdot z + 1 \cdot 3 \cdot z - 1 \cdot z + 1 \cdot 3 \cdot z - 1 \cdot z + 1 \cdot 3 \cdot z - 1 \cdot z + 1 \cdot 3 \cdot z - 1 \cdot z + 1 \cdot 3 \cdot z - 1 \cdot z + 1 \cdot 3 \cdot z - 1 \cdot z + 1 \cdot 3 \cdot z - 1 \cdot z + 1 \cdot 3 \cdot z - 1 \cdot z + 1 \cdot 3 \cdot z - 1 \cdot z + 1 \cdot 3 \cdot z - 1 \cdot z + 1 \cdot 3 \cdot z - 1 \cdot z + 1 \cdot 3 \cdot z - 1 \cdot z + 1 \cdot 3 \cdot z - 1 \cdot z - 1 \cdot z + 1 \cdot 3 \cdot z - 1 \cdot z -
 \{z+1\}+\{\frac{1}{3}\}\{\left(\frac{z-1}{z+1}\right)^{3}}{\left(\frac{z-1}{z+1}\right)^{3}}=1  (\frac \{z-1\}\{z+1\}\}\left(\frac{z-1}{z+1}\right)^{3}+\frac{1}{2k+1}}\left(\frac{z-1}{z+1}\right)^{3}+\frac{1}{2k+1}}\left(\frac{z-1}{z+1}\right)^{3}
 1{z+1}\right)^{2k+1}.} This series can be derived from the above Taylor series. It converges quicker than the Taylor series, especially if z is close to 1. For example, for z = 1.5, the first three terms of the second series approximate ln(1.5) with an error of about 3 \times 10 - 6. The quick convergence for z close to 1 can be taken advantage of in the
 following way: given a low-accuracy approximation y \approx \ln(z) and putting A = z \exp(y), {\displaystyle A = \sqrt{y}, {\displaystyle A={\frac {z}{\exp(y)}},} the logarithm of z is: \ln(z) = y + \ln(A). {\displaystyle A={\frac {z}}\exp(y)}, the logarithm of z is: \ln(z) = y + \ln(A).
 exponential series, which converges quickly provided y is not too large. Calculating the logarithm of larger z can be reduced to smaller values of z by writing z = a \cdot 10b, so that \ln(z) = \ln(a) + b \cdot \ln(10). A closely related method can be used to compute the logarithm of integers. Putting z = n + 1 n {\displaystyle \textstyle z = {\frac{n+1}{n}}} in the
above series, it follows that: \ln (n + 1) = \ln (n) + 2\sum k = 0 \infty 12 k + 1 (12 n + 1) 2 k + 1 . {\clinp{1}{2k+1}} \left( \frac{1}{2k+1} \right)  If the logarithm of a large integer n is known, then this series yields a fast converging series for \log(n+1), with a rate of convergence of (1)
2 n + 1) 2 {\textstyle \left(\frac {1}{2n+1}}\right)^{2}}. The arithmetic-geometric mean yields high-precision approximations of the natural logarithm. Sasaki and Kanada showed in 1982 that it was particularly fast for precisions between 400 and 1000 decimal places, while Taylor series methods were typically faster when less precision was
needed. In their work \ln(x) is approximated to a precision of 2-p (or p precise bits) by the following formula (due to Carl Friedrich Gauss):[51][52] \ln(x) \approx \pi 2 M (1, 22 - m/x) - m \ln(2). {\displaystyle \\ln(x) \approx \pi 2 M (1, 22 - m/x) - m \ln(2).}
y. It is obtained by repeatedly calculating the average (x + y)/2 (arithmetic mean) and x y {\textstyle {\sqrt {xy}}} (geometric mean) of x and y then let those two numbers quickly converge to a common limit which is the value of M(x, y). m is chosen such that x \ge m > 2 p / 2. {\displaystyle}
x\,2^{m}>2^{p/2}.\,} to ensure the required precision. A larger m makes the M(x, y) calculation take more steps (the initial x and y are farther apart so it takes more steps to converge) but gives more precision. The constants π and ln(2) can be calculated with quickly converging series. While at Los Alamos National Laboratory working on the
Manhattan Project, Richard Feynman developed a bit-processing algorithm to compute the logarithm to long division and was later used in the Connection Machine. The algorithm to compute the logarithm to long division and was later used in the Connection Machine. The algorithm to compute the logarithm that is similar to long division and was later used in the Connection Machine.
sequentially builds that product P, starting with P = 1 and k = 1: if P \cdot (1 + 2 - k) < x, then it changes P to P \cdot (1 + 2 - k) < x, then it changes P to P \cdot (1 + 2 - k) < x, then it changes P to P \cdot (1 + 2 - k) < x, then it changes P to P \cdot (1 + 2 - k) < x, then it changes P to P \cdot (1 + 2 - k) < x, then it changes P to P \cdot (1 + 2 - k) < x, then it changes P to P \cdot (1 + 2 - k) < x, then it changes P to P \cdot (1 + 2 - k) < x, then it changes P to P \cdot (1 + 2 - k) < x, then it changes P to P \cdot (1 + 2 - k) < x, then it changes P to P \cdot (1 + 2 - k) < x, then it changes P to P \cdot (1 + 2 - k) < x, then it changes P to P \cdot (1 + 2 - k) < x, then it changes P to P \cdot (1 + 2 - k) < x, then it changes P to P \cdot (1 + 2 - k) < x, then it changes P to P \cdot (1 + 2 - k) < x, then it changes P to P \cdot (1 + 2 - k) < x, then it changes P to P \cdot (1 + 2 - k) < x, then it changes P to P \cdot (1 + 2 - k) < x, then it changes P to P \cdot (1 + 2 - k) < x, then it changes P to P \cdot (1 + 2 - k) < x, then it changes P to P \cdot (1 + 2 - k) < x, then it changes P to P \cdot (1 + 2 - k) < x, then it changes P to P \cdot (1 + 2 - k) < x, then it changes P to P \cdot (1 + 2 - k) < x, then it changes P to P \cdot (1 + 2 - k) < x, then it changes P to P \cdot (1 + 2 - k) < x, then it changes P to P \cdot (1 + 2 - k) < x, then it changes P to P \cdot (1 + 2 - k) < x, then it changes P to P \cdot (1 + 2 - k) < x, then it changes P to P \cdot (1 + 2 - k) < x, then it changes P to P \cdot (1 + 2 - k) < x, then it changes P to P \cdot (1 + 2 - k) < x, then it changes P to P \cdot (1 + 2 - k) < x, then it changes P to P \cdot (1 + 2 - k) < x, then it changes P to P \cdot (1 + 2 - k) < x, then it changes P to P \cdot (1 + 2 - k) < x, then it changes P to P \cdot (1 + 2 - k) < x, then it changes P to P \cdot (1 + 2 - k) < x, then it changes P to P \cdot (1 + 2 - k) < x, then it changes P to P \cdot (1 + 2 - k) < x, then it changes P to P \cdot (1 + 2 - k) < x, then it changes P to P \cdot (1 + 2 - k) < x, then it changes P to P \cdot (1 + 2 - k) < x, then it chan
factor 1 + 2-k was included in the product P, log(x) may be computed by simple addition, using a table of log(1 + 2-k) for all k. Any base may be used for the logarithms have many applications inside and outside mathematics. Some of these occurrences are related to the notion of
scale invariance. For example, each chamber of the shell of a nautilus is an approximate copy of the next one, scaled by a constant factor. This gives rise to a logarithms are also linked to self-similarity. For example, logarithms
appear in the analysis of algorithms that solve a problem by dividing it into two similar smaller problems and patching their solutions. [56] The dimensions of self-similar geometric shapes, that is, shapes whose parts resemble the overall picture are also based on logarithms. Logarithms. Logarithms that solve a problem by dividing it into two similar smaller problems and patching their solutions.
 opposed to its absolute difference. Moreover, because the logarithmic function log(x) grows very slowly for large x, logarithmic scales are used to compress large-scale scientific data. Logarithmic function, or the Nernst equation, or the Nernst equation. Main article: Logarithmic
scale A logarithmic chart depicting the value of one Goldmark in Papiermarks during the German hyperinflation in the 1920s Scientific quantities are often expressed as logarithmic scale quantities. It is based on the common
 logarithm of ratios—10 times the common logarithm of a power ratio or 20 times the common logarithm of a voltage ratio. It is used to quantify the attenuation or amplification of electrical signals,[57] to describe power levels of sounds in acoustics,[58] and the absorbance of light in the fields of spectrometry and optics. The signal-to-noise ratio
 describing the amount of unwanted noise in relation to a (meaningful) signal is also measured in decibels. [59] In a similar vein, the peak signal-to-noise ratio is commonly used to assess the quality of sound and image compression methods using the logarithm.
energy emitted at the quake. This is used in the moment magnitude scale or the Richter magnitude scale or the Richter magnitude scale or the Richter magnitude scale or the decimal logarithm
the decimal cologarithm, is indicated by the letter p.[63] For instance, pH is the decimal cologarithm of the activity of hydronium ions (the form hydronium ions (the form hydronium ions to a ratio of 104 mol·L-1, hence a pH of 7. Vinegar typically has a pH of about 3. The difference of 4 corresponds to a ratio of 104 mol·L-1, hence a pH of 7. Vinegar typically has a pH of about 3. The difference of 4 corresponds to a ratio of 104 mol·L-1, hence a pH of 7. Vinegar typically has a pH of about 3. The difference of 4 corresponds to a ratio of 104 mol·L-1, hence a pH of 7. Vinegar typically has a pH of about 3. The difference of 4 corresponds to a ratio of 104 mol·L-1, hence a pH of 7. Vinegar typically has a pH of about 3. The difference of 4 corresponds to a ratio of 104 mol·L-1, hence a pH of 7. Vinegar typically has a pH of 8. Vinegar typically h
of the activity, that is, vinegar's hydronium ion activity is about 10-3 mol·L-1. Semilog (log-linear) graphs use the logarithmic scale concept for visualization: one axis, typically the vertical one, is scaled logarithmic scale concept for visualization: one axis, typically the vertical one, is scaled logarithmic scale concept for visualization: one axis, typically the vertical one, is scaled logarithmic scale concept for visualization: one axis, typically the vertical one, is scaled logarithmic scale concept for visualization for the vertical one, is scaled logarithmic scale concept for visualization for visualizat
as the increase from 1 to 1 million. In such graphs, exponential functions of the form f(x) = a · xk to be depicted as straight lines with slope equal to the exponent k. This is applied in visualizing
and analyzing power laws.[65] Logarithms occur in several laws describing human perception:[66][67] Hick's law proposes a logarithmic relation between the time required to rapidly move to a target area is a logarithmic function of the
 ratio between the distance to a target and the size of the target. [69] In psychophysics, the Weber-Fechner law proposes a logarithmic relationship between stimulus and sensation such as the actual vs. the perceived weight of an item a person is carrying. [70] (This "law", however, is less realistic than more recent models, such as Stevens's power law.
[71]) Psychological studies found that individuals with little mathematics education tend to estimate quantities logarithm, so that 10 is positioned as close to 100 as 100 is to 1000. Increasing education shifts this to a linear estimate (positioning 1000 10 times as far
away) in some circumstances, while logarithms are used when the numbers to be plotted are difficult to plot linearly.[72][73] Three probability density functions (PDF) of random variables with log-normal distributions. The location parameter µ, which is zero for all three of the PDFs shown, is the mean of the logarithm of the random variable, not the
mean of the variable itself. Distribution of first digits (in %, red bars) in the population of the 237 countries of the world. Black dots indicate the distribution predicted by Benford's law. Logarithms arise in probability theory: the law of large numbers dictates that, for a fair coin, as the number of coin-tosses increases to infinity, the observed proportion
of heads approaches one-half. The fluctuations of this proportion about one-half are described by the law of the iterated logarithm of a random variable has a normal distribution, the variable is said to have a log-normal distribution. [75] Log-normal distributions are
 encountered in many fields, wherever a variable is formed as the product of many independent positive random variables, for example in the study of turbulence. [76] Logarithms are used for maximum-likelihood estimation of parameter that must be
 estimated. A maximum of the likelihood function occurs at the same parameter-value as a maximum of the logarithm is an increasing function. The logarithm of the likelihood is easier to maximize, especially for the multiplied likelihood function occurs at the same parameter-value as a maximum of the logarithm is an increasing function. The logarithm is an increasing function.
 occurrence of digits in many data sets, such as heights of buildings. According to Benford's law, the probability that the first decimal-digit of an item in the data sample is d (from 1 to 9) equals log10 (d), regardless of the unit of measurement. [78] Thus, about 30% of the data can be expected to have 1 as first digit, 18% start with 2, etc.
Auditors examine deviations from Benford's law to detect fraudulent accounting. [79] The logarithms transformation used to bring the empirical distribution closer to the assumed one. Analysis of algorithms is a branch of computer science that studies the performance of algorithms (computer programs solving a certain
problem).[80] Logarithms are valuable for describing algorithms that divide a problem into smaller ones, and join the solutions of the subproblems.[81] For example, to find a number in a sorted list, the binary search algorithm checks the middle entry if the number is still not found. This
 algorithm requires, on average, log2 (N) comparisons, where N is the list's length.[82] Similarly, the merge sort algorithm sypically require a time approximately proportional to N · log(N).[83] The base of the logarithm is not
 organism growth, however, use this term for an exponential function. [85]) For example, any natural number N can be represented in binary form in no more than log2 N + 1 bits. In other words, the amount of memory needed to store N grows logarithmically with N. Billiards on an oval billiard table. Two particles, starting at the center with an angle
 differing by one degree, take paths that diverge chaotically because of reflections at the boundary. Entropy is broadly a measure of the disorder of some physical system is defined as S = -k \sum i p i \ln (p i). {\displaystyle S = -k \sum i p i \ln (p i). {\displaystyle S = -k \sum i p i \ln (p i). {\displaystyle S = -k \sum i p i \ln (p i).}
of the system in question, such as the positions of gas particles in a container. Moreover, pi is the probability that the state i is attained and k is the Boltzmann constant. Similarly, entropy in information theory measures the quantity of information theory measures the quantity of information. If a message recipient may expect any one of N possible messages with equal likelihood, then the
amount of information conveyed by any one such message is quantified as log2 N bits.[86] Lyapunov exponents use logarithms to gauge the degree of chaoticity of a dynamical system. For example, for a particle moving on an oval billiard table, even small changes of the initial conditions result in very different paths of the particle. Such systems are
 chaotic in a deterministic way, because small measurement errors of the initial state predictably lead to largely different final states. [87] At least one Lyapunov exponent of a deterministically chaotic system is positive. The Sierpinski triangle (at the right) is constructed by repeatedly replacing equilateral triangles by three smaller ones. Logarithms
 occur in definitions of the dimension of fractals. [88] Fractals are geometric objects that are self-similar in the sense that small parts reproduce, at least roughly, the entire global structure. The Sierpinski triangle (pictured) can be covered by three copies of itself, each having sides half the original length. This makes the Hausdorff dimension of 
structure ln(3)/ln(2) ≈ 1.58. Another logarithm-based notion of dimension is obtained by counting the number of boxes needed to cover the fractal in question. Four different octaves shown on a logarithmic scale (as the ear hears them) Logarithms are related to musical tones and intervals. In equal temperament tunings
the frequency ratio depends only on the interval between two tones, not on the specific frequency, or pitch, of the individual tones. In the 12-tone equal temperament tuning common in modern Western music, each octave (doubling of frequency) is broken into twelve equally spaced intervals called semitones. For example, if the note A has a frequency
of 440 Hz then the note B-flat has a frequency of 466 Hz. The interval between A and B-flat is a semitone, as is the one between B-flat and B (frequency 493 Hz). Accordingly, the frequency of 466 \} \approx 1.059\approx 1.059\approx 1.059\approx 1.2}\[ \{12\} \] \[ \{12\} \] \[ \{12\} \] \[ \{12\} \] \[ \{12\} \] \[ \{12\} \] \[ \{12\} \] \[ \{12\} \] \[ \{12\} \] \[ \{12\} \] \[ \{12\} \] \[ \{12\} \] \[ \{12\} \] \[ \{12\} \] \[ \{12\} \] \[ \{12\} \] \[ \{12\} \] \[ \{12\} \] \[ \{12\} \] \[ \{12\} \] \[ \{12\} \] \[ \{12\} \] \[ \{12\} \] \[ \{12\} \] \[ \{12\} \] \[ \{12\} \] \[ \{12\} \] \[ \{12\} \] \[ \{12\} \] \[ \{12\} \] \[ \{12\} \] \[ \{12\} \] \[ \{12\} \] \[ \{12\} \] \[ \{12\} \] \[ \{12\} \] \[ \{12\} \] \[ \{12\} \] \[ \{12\} \] \[ \{12\} \] \[ \{12\} \] \[ \{12\} \] \[ \{12\} \] \[ \{12\} \] \[ \{12\} \] \[ \{12\} \] \[ \{12\} \] \[ \{12\} \] \[ \{12\} \] \[ \{12\} \] \[ \{12\} \] \[ \{12\} \] \[ \{12\} \] \[ \{12\} \] \[ \{12\} \] \[ \{12\} \] \[ \{12\} \] \[ \{12\} \] \[ \{12\} \] \[ \{12\} \] \[ \{12\} \] \[ \{12\} \] \[ \{12\} \] \[ \{12\} \] \[ \{12\} \] \[ \{12\} \] \[ \{12\} \] \[ \{12\} \] \[ \{12\} \] \[ \{12\} \] \[ \{12\} \] \[ \{12\} \] \[ \{12\} \] \[ \{12\} \] \[ \{12\} \] \[ \{12\} \] \[ \{12\} \] \[ \{12\} \] \[ \{12\} \] \[ \{12\} \] \[ \{12\} \] \[ \{12\} \] \[ \{12\} \] \[ \{12\} \] \[ \{12\} \] \[ \{12\} \] \[ \{12\} \] \[ \{12\} \] \[ \{12\} \] \[ \{12\} \] \[ \{12\} \] \[ \{12\} \] \[ \{12\} \] \[ \{12\} \] \[ \{12\} \] \[ \{12\} \] \[ \{12\} \] \[ \{12\} \] \[ \{12\} \] \[ \{12\} \] \[ \{12\} \] \[ \{12\} \] \[ \{12\} \] \[ \{12\} \] \[ \{12\} \] \[ \{12\} \] \[ \{12\} \] \[ \{12\} \] \[ \{12\} \] \[ \{12\} \] \[ \{12\} \] \[ \{12\} \] \[ \{12\} \] \[ \{12\} \] \[ \{12\} \] \[ \{12\} \] \[ \{12\} \] \[ \{12\} \] \[ \{12\} \] \[ \{12\} \] \[ \{12\} \] \[ \{12\} \] \[ \{12\} \] \[ \{12\} \] \[ \{12\} \] \[ \{12\} \] \[ \{12\} \] \[ \{12\} \] \[ \{12\} \] \[ \{12\} \] \[ \{12\} \] \[ \{12\} \] \[ \{12\} \] \[ \{12\} \] \[ \{12\} \] \[ \{12\} \] \[ \{12\} \] \[ \{12\} \] 
Intervals between arbitrary pitches can be measured in octaves by taking the base-2 logarithm of the frequency ratio, can be measured in equally tempered semitones by taking the base-21/1200 logarithm (1200 times the base-21/1200 logarithm), or can be measured in cents, hundredths of a semitone, by taking the base-21/1200 logarithm (1200 times the base-21/1200 logarithm).
2 logarithm). The latter is used for finer encoding, as it is needed for finer measurements or non-equal temperaments. [89] Interval (the two tones are played at the same time) 1/12 tone play Semitone play Just major third play Tritone play Octave play Frequency ratio r {\displaystyle r} 2 1 72 \approx 1.0097 {\displaystyle 2^{\frac {1}}}
 \{72\} \approx 1.0097\} 2\ 1\ 12 \approx 1.0595 \displaystyle \approx 1.0595 \displaystyle \hegin \aligned \end{2^{\frac{6}{12}}} = 1.25 \end{aligned} 2^{\frac{6}{12}} = 2 \approx 1.4142 \displaystyle \hegin \aligned \end{2^{\frac{6}{12}}} = \{1.25\} \end{aligned} \end{2^{\frac{6}{12}}} = 1.25 \end{2^{\frac{
   \{2\}\\&\approx 1.4142\end{aligned}}\} 2 12 12 = 2 {\displaystyle 2^{\frac {12}{12}}=2} Number of semitones 12 log 2 r {\displaystyle 1} \approx 3.8631 {\displaystyle \approx 3.8631} 4 {\displaystyle 4} 6 {\displaystyle 6} 12 {\displaystyle 12} Number of cents 1200 log 2 r
  \{\text{displaystyle 1200} \ \{2\}r\}\ 16\ 2\ \{\text{displaystyle 16}\ 16\ 2\ \{3\}\}\ 100\ \{\text{displaystyle 100}\ \approx 386.31\ \{\text{displaystyle 1200}\ \text{Natural logarithms}\ \text{are closely linked to counting prime numbers}\ (2, 3, 5, 7, 11, ...), an important topic in number theory. For any
 integer x, the quantity of prime numbers less than or equal to x is denoted \pi(x). The prime number theorem asserts that \pi(x) is approximately given by x ln (x), \pi(x), and that fraction approaches 1 when x tends to infinity. [90] As a consequence, the probability that a randomly chosen
 number between 1 and x is prime is inversely proportional to the number of decimal digits of x. A far better estimate of \pi(x) is given by the offset logarithmic integral function Li(x), defined by L i (x) = \int 2 x 1 \ln (t) dt. {\displaystyle \mathrm {Li} (x) = \int 2 x 1 \ln (t) dt.} The Riemann hypothesis, one of the oldest open
 mathematical conjectures, can be stated in terms of comparing \pi(x) and \pi(x)=1 the interval logarithm of n factorial, \pi(x)=1 the interval logarithm of n factorial logarithm.
can be used to obtain Stirling's formula, an approximation of n! for large n.[92] Main article: Complex logarithm Polar form of z = x + iy. Both \varphi and \varphi' are arguments of z, when z is (considered as) a complex number. A complex number of z are arguments of z, when z is (considered as) a complex number.
number is commonly represented as z = x + iy, where x and y are real numbers and i is an imaginary unit, the square of which is -1. Such a number can be visualized by a point in the complex plane, as shown at the right. The polar form encodes a non-zero complex number z by its absolute value, that is, the (positive, real) distance r to the origin, and
denoted as z = x + iy = r (cos (\phi + 2k\pi) + i\sin(\phi) = r (cos (\phi + 2k\pi) 
arguments of z for all integers k, because adding 2k\pi radians or k\cdot360^{\circ} [nb 6] to \phi corresponds to "winding" around the origin counter-clock-wise by k turns. The resulting complex number is always z, as illustrated at the right for k=1. One may select exactly one of the possible arguments of z as the so-called principal argument, denoted Arg(z), with
a capital A, by requiring \phi to belong to one, conveniently selected turn, e.g. -\pi < \phi \le \pi[93] or 0 \le \phi < 2\pi.[94] These regions, where the argument function. The principal branch (-\pi, \pi) of the complex logarithm, Log(z). The black point at z = 1 corresponds to absolute value zero and
brighter colors refer to bigger absolute values. The hue of the color encodes the argument of Log(z). Euler's formula connects the trigonometric functions sine and cosine to the complex exponential: e i \phi = cos \phi + i sin \phi. {\displaystyle e^{i\varphi}} =\cos \varphi + i\sin \varphi \text{ | Varphi | } =\cos \varphi + i\sin \varphi \text{ | Varphi | } =\cos \varphi + i\sin \varphi \text{ | Varphi | } =\cos \varphi + i\sin \varphi \text{ | Varphi | } =\cos \varphi + i\sin \varphi \text{ | Varphi | } =\cos \varphi + i\sin \varphi \text{ | Varphi | } =\cos \varphi + i\sin \varphi \text{ | Varphi | } =\cos \varphi + i\sin \varphi \text{ | Varphi | } =\cos \varphi + i\sin \varphi \text{ | Varphi | } =\cos \varphi + i\sin \varphi \text{ | Varphi | } =\cos \varphi + i\sin \varphi \text{ | Varphi | } =\cos \varphi + i\sin \varphi \text{ | Varphi | } =\cos \varphi + i\sin \varphi \text{ | Varphi | } =\cos \varphi + i\sin \varphi \text{ | Varphi | } =\cos \varphi + i\sin \varphi \text{ | Varphi | } =\cos \varphi + i\sin \varphi \text{ | Varphi | } =\cos \varphi + i\sin \varphi \text{ | Varphi | } =\cos \varphi + i\sin \varphi \text{ | Varphi | } =\cos \varphi + i\sin \varphi \text{ | Varphi | } =\cos \varphi + i\sin \varphi \text{ | Varphi | } =\cos \varphi + i\sin \varphi \text{ | Varphi | } =\cos \varphi + i\sin \varphi \text{ | Varphi | } =\cos \varphi + i\sin \varphi \text{ | Varphi | } =\cos \varphi + i\sin \varphi \text{ | Varphi | } =\cos \varphi + i\sin \varphi \text{ | Varphi | } =\cos \varphi + i\sin \varphi \text{ | Varphi | } =\cos \varphi + i\sin \varphi \text{ | Varphi | } =\cos \varphi + i\sin \varphi \text{ | Varphi | } =\cos \varphi + i\sin \varphi \text{ | Varphi | } =\cos \varphi + i\sin \varphi + 
 hold: [95] \ z = r(\cos \varphi + i \sin \varphi) = r(\cos (\varphi + 2 \ k \ \pi) + i \sin (\varphi + 2 \ k \ \pi) = e \ln (r) + i (\varphi + 2 \ k \ \pi) = e \ln (r) + i (\varphi + 2 \ k \ \pi) = e \ln (r) + i (\varphi + 2 \ k \ \pi) = e \ln (r) + i (\varphi + 2 \ k \ \pi) = e \ln (r) + i (\varphi + 2 \ k \ \pi) = e \ln (r) + i (\varphi + 2 \ k \ \pi) = e \ln (r) + i (\varphi + 2 \ k \ \pi) = e \ln (r) + i (\varphi + 2 \ k \ \pi) = e \ln (r) + i (\varphi + 2 \ k \ \pi) = e \ln (r) + i (\varphi + 2 \ k \ \pi) = e \ln (r) + i (\varphi + 2 \ k \ \pi) = e \ln (r) + i (\varphi + 2 \ k \ \pi) = e \ln (r) + i (\varphi + 2 \ k \ \pi) = e \ln (r) + i (\varphi + 2 \ k \ \pi) = e \ln (r) + i (\varphi + 2 \ k \ \pi) = e \ln (r) + i (\varphi + 2 \ k \ \pi) = e \ln (r) + i (\varphi + 2 \ k \ \pi) = e \ln (r) + i (\varphi + 2 \ k \ \pi) = e \ln (r) + i (\varphi + 2 \ k \ \pi) = e \ln (r) + i (\varphi + 2 \ k \ \pi) = e \ln (r) + i (\varphi + 2 \ k \ \pi) = e \ln (r) + i (\varphi + 2 \ k \ \pi) = e \ln (r) + i (\varphi + 2 \ k \ \pi) = e \ln (r) + i (\varphi + 2 \ k \ \pi) = e \ln (r) + i (\varphi + 2 \ k \ \pi) = e \ln (r) + i (\varphi + 2 \ k \ \pi) = e \ln (r) + i (\varphi + 2 \ k \ \pi) = e \ln (r) + i (\varphi + 2 \ k \ \pi) = e \ln (r) + i (\varphi + 2 \ k \ \pi) = e \ln (r) + i (\varphi + 2 \ k \ \pi) = e \ln (r) + i (\varphi + 2 \ k \ \pi) = e \ln (r) + i (\varphi + 2 \ k \ \pi) = e \ln (r) + i (\varphi + 2 \ k \ \pi) = e \ln (r) + i (\varphi + 2 \ k \ \pi) = e \ln (r) + i (\varphi + 2 \ k \ \pi) = e \ln (r) + i (\varphi + 2 \ k \ \pi) = e \ln (r) + i (\varphi + 2 \ k \ \pi) = e \ln (r) + i (\varphi + 2 \ k \ \pi) = e \ln (r) + i (\varphi + 2 \ k \ \pi) = e \ln (r) + i (\varphi + 2 \ k \ \pi) = e \ln (r) + i (\varphi + 2 \ k \ \pi) = e \ln (r) + i (\varphi + 2 \ k \ \pi) = e \ln (r) + i (\varphi + 2 \ k \ \pi) = e \ln (r) + i (\varphi + 2 \ k \ \pi) = e \ln (r) + i (\varphi + 2 \ k \ \pi) = e \ln (r) + i (\varphi + 2 \ k \ \pi) = e \ln (r) + i (\varphi + 2 \ k \ \pi) = e \ln (r) + i (\varphi + 2 \ k \ \pi) = e \ln (r) + i (\varphi + 2 \ k \ \pi) = e \ln (r) + i (\varphi + 2 \ k \ \pi) = e \ln (r) + i (\varphi + 2 \ k \ \pi) = e \ln (r) + i (\varphi + 2 \ k \ \pi) = e \ln (r) + i (\varphi + 2 \ k \ \pi) = e \ln (r) + i (\varphi + 2 \ k \ \pi) = e \ln (r) + i (\varphi + 2 \ k \ \pi) = e \ln (r) + i (\varphi + 2 \ k \ \pi) = e \ln (r) + i (\varphi + 2 \ k \ \pi) = e \ln (r) + i (\varphi + 2 \ k \ \pi) = e \ln (r) + i (\varphi + 2 \ k \ \pi) = e \ln (r) + i (\varphi + 2 \ k \ \pi) = e \ln (r) + i (\varphi + 2 \ k \ \pi) = e \ln (r) + i (\varphi + 2 \ k \ \pi) = e \ln (r) + i (\varphi + 2 \ k \ \pi) = e \ln (r) + i (\varphi + 2 \ k \ \pi) = e \ln (r) + i (\varphi + 2 \ k \ \pi) = e \ln (r) + i (\varphi +
 +2k\pi) |\&=e^{\ln(r)+i(\varphi+2k\pi)}=e^{a_{k}},\end{aligned}} where ln(r) is the unique real natural logarithms of z, which are all those complex values ak for which the ak-th power of e equals z, are the infinitely many values a k = ln ( real natural logarithms) is the unique real natural logarithms of z, and k is an arbitrary integer. Therefore, the complex logarithms of z, which are all those complex values ak for which the ak-th power of e equals z, are the infinitely many values ak | ln ( real natural logarithms) | ln ( real na
) + i (\varphi + 2 k \pi), {\displaystyle a_{k}=\ln(r)+i(\varphi + 2k\pi),} for arbitrary integers k. Taking k such that \varphi + 2k\pi is within the defined interval for the principal argument of any positive real number x is 0; hence Log(x) is a real
 number and equals the real (natural) logarithm. However, the above formulas for logarithms of products and powers do not generalize to the principal value of the complex logarithm. However, the above formulas for logarithm has
discontinuities all along the negative real x axis, which can be seen in the jump in the hue there. This discontinuity arises from jumping to the continuously neighboring branch. Such a locus is called a branch cut. Dropping the range
restrictions on the argument makes the relations "argument of z", and consequently the "logarithm of a matrix is the (multi-valued) inverse function of the matrix exponential.[97]
 Another example is the p-adic logarithm, the inverse function of the p-adic exponential. Both are defined via Taylor series analogous to the real case. [98] In the context of differential geometry, the exponential map maps the tangent space at a point of a manifold to a neighborhood of that point. Its inverse is also called the logarithmic (or log) map. [99]
In the context of finite groups exponentiation is given by repeatedly multiplying one group element b with itself. The discrete logarithm is the integer n solving the equation b n = x, {\displaystyle b^{n}=x,} where x is an element of the group. Carrying out the exponentiation can be done efficiently, but the discrete logarithm is believed to be very
hard to calculate in some groups. This asymmetry has important applications in public key cryptography, such as for example in the Diffie-Hellman key exchanges of cryptography, such as for example in the Diffie-Hellman key exchanges of cryptography, such as for example in the Diffie-Hellman key exchanges of cryptography, such as for example in the Diffie-Hellman key exchanges of cryptography, such as for example in the Diffie-Hellman key exchanges of cryptography, such as for example in the Diffie-Hellman key exchanges of cryptography, such as for example in the Diffie-Hellman key exchanges of cryptography, such as for example in the Diffie-Hellman key exchanges of cryptography, such as for example in the Diffie-Hellman key exchanges of cryptography, such as for example in the Diffie-Hellman key exchanges of cryptography, such as for example in the Diffie-Hellman key exchanges of cryptography, such as for example in the Diffie-Hellman key exchanges of cryptography, such as for example in the Diffie-Hellman key exchanges of cryptography, such as for example in the Diffie-Hellman key exchanges of cryptography, such as for example in the Diffie-Hellman key exchanges of cryptography, such as for example in the Diffie-Hellman key exchanges of cryptography, such as for example in the Diffie-Hellman key exchanges of cryptography.
non-zero elements of a finite field.[101] Further logarithm like inverse functions include the double logarithm in computer science), the Lambert W function, and the logit. They are the inverse functions of the double exponential function, tetration, of f(w)
 = wew,[102] and of the logistic function, respectively.[103] From the perspective of group theory, the identity log(cd) = log(c) + log(d) expresses a group isomorphism between these groups.[104] By means of that
isomorphism, the Haar measure (Lebesgue measure) dx on the reals corresponds to the Haar measure dx/x on the positive reals. [105] The non-negative reals not only have a multiplication, but also have addition, and form a semiring; this is in fact a semifield. The logarithm then takes multiplication to addition (log
 multiplication), and takes addition to log addition (LogSumExp), giving an isomorphism of semirings between the probability semiring and the log semiring to logarithmic one-forms df/f appear in complex analysis and algebraic geometry as differential forms with logarithmic poles. [106] The polylogarithm is the function defined by Li s (z) = \sum k = 1 \propto 1
z k k s. {\displaystyle \operatorname {Li} _{s}(z)=\sum_{k=1}^{\infty} {z^{k} \over k^{s}}.} It is related to the natural logarithm by Li1 (z) = -\ln(1-z). Moreover, Lis (1) equals the Riemann zeta function \zeta(s).[107] Mathematics portalChemistry portalGeography portalEngineering portal Decimal exponent (dex) Exponential
 function Index of logarithm articles ^The restrictions on x and b are explained in the section "Analytic properties". ^The restrictions on x and b are explained in the section "Analytic properties". ^The restrictions on x and b are explained in the section "Analytic properties". ^The restrictions on x and b are explained in the section "Analytic properties". ^The restrictions on x and b are explained in the section "Analytic properties". ^The restrictions on x and b are explained in the section "Analytic properties". ^The restrictions on x and b are explained in the section "Analytic properties". ^The restrictions on x and b are explained in the section "Analytic properties".
  _{b}x\cdot \log _{k}b.} The formula follows by solving for log b x . {\displaystyle \log _{b}x.} ^ z Some mathematicians disapprove of this notation", which he said no mathematician had ever used.[16] The notation was invented by the 19th century
 mathematician I. Stringham.[17][18] ^{\circ} The same series holds for the principal value of the complex logarithm for complex numbers z satisfying |z - 1| < 1. ^{\circ} The same series holds for the principal value of the complex numbers z satisfying |z - 1| < 1. ^{\circ} The same series holds for the principal value of the complex numbers z satisfying |z - 1| < 1. ^{\circ} The same series holds for the principal value of the complex numbers z satisfying |z - 1| < 1. ^{\circ} The same series holds for the principal value of the complex numbers z with positive real part. ^{\circ} See radian for the conversion between 2π and 360 degree. ^{\circ} Hobson
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Cambridge University Press, pp. 868-77 Retrieved from "Use this log calculator to easily calculate the logarithm of a number with a given base: logb(x). The default base is the inverse to exponentiation, meaning that the log of a number is the exponent to
which another fixed number called a "base" was raised to produce the number of multiplications of the same factor - in this case 2. The notation is logbx or logb(x) where b is the base and x is the number for which the logarithm is to be
found. There are several named logarithms: the common logarithm has a base of 10 (b = 10, log10), while the binary logarithm has a base of 2. The common logarithm has a base of the number, ~2.718), while the binary logarithm has a base of 2. The common logarithm has a base of 2. The common logarithm has a base of 2. The common logarithm has a base of 3. The common logarithm has a base of 3. The common logarithm has a base of 4.
natural logarithm is widely used in math and physics due to its simpler derivative. The binary logarithm, and leave the "Base" field empty to get the
natural logarithm calculated. The graph above presents the values for the common, natural and binary logarithm functions for the values from 0.1 to 20 (logarithm functions for the values from 0.1 to 20 (logarithm functions for the values from 0.1 to 20 (logarithm functions for the values from 0.1 to 20 (logarithm functions for the values from 0.1 to 20 (logarithm functions for the values from 0.1 to 20 (logarithm functions for the values from 0.1 to 20 (logarithm functions for the values from 0.1 to 20 (logarithm functions for the values from 0.1 to 20 (logarithm functions for the values from 0.1 to 20 (logarithm functions for the values from 0.1 to 20 (logarithm functions for the values from 0.1 to 20 (logarithm functions for the values from 0.1 to 20 (logarithm functions for the values from 0.1 to 20 (logarithm functions for the values from 0.1 to 20 (logarithm functions for the values from 0.1 to 20 (logarithm functions for the values from 0.1 to 20 (logarithm functions for the values from 0.1 to 20 (logarithm functions for the values from 0.1 to 20 (logarithm functions for the values from 0.1 to 20 (logarithm functions for the values from 0.1 to 20 (logarithm functions for the values from 0.1 to 20 (logarithm functions for the values from 0.1 to 20 (logarithm functions for the values from 0.1 to 20 (logarithm functions for the values from 0.1 to 20 (logarithm functions for the values from 0.1 to 20 (logarithm functions for the values from 0.1 to 20 (logarithm functions for the values from 0.1 to 20 (logarithm functions for the values from 0.1 to 20 (logarithm functions for the values from 0.1 to 20 (logarithm functions for the values from 0.1 to 20 (logarithm functions for the values from 0.1 to 20 (logarithm functions for the values from 0.1 to 20 (logarithm functions for the values from 0.1 to 20 (logarithm functions for the values from 0.1 to 20 (logarithm functions for the values from 0.1 to 20 (logarithm functions for the values from 0.1 to 20 (logarithm functions for the values from 0.1 to 20 (logarit
logs using power series or the arithmetic-geometric mean. A pre-calculated table can also be of use if only a range of bases and logarithms are of interest on a daily basis. For anything else it is most convenient to use an online log calculator like this one due to its ease of use. Here are some quick rules for calculating especially simple logarithms. If
the base and the number are the same, e.g. \log 1010, the result is 1 (b1 = b for any b), while if the number is one, \log 20.125 = -3, since 2.3 = 1/23 = 1/8 = 0.125. Example \log 20.125 = -3, since 2.3 = 1/8 = 0.125. Example \log 20.125 = -3, since 2.3 = 1/8 = 0.125.
x = 64. That's a log with base 2, \log 2. \log 327 = 3, since 33 = 3 \times 3 \times 3 = 27. That's a log with base 3. \log 101000 = 3, since 103 = 10 \times 10 \times 10 = 1000. That's a log with base 2, \log 327 = 3, since 103 = 10 \times 10 \times 10 = 1000. That's a log with base 2.
decibel scale in which the unit (dB) expresses log-ratios of signal power and amplitude - mostly used for sound waves. pH is a well-known chemistry scale for measuring acidity. Discrete logarithms have uses in public-key cryptography, such as the one used to deliver this log calculator securely to you, making sure no one can eavesdrop on your
communication with our website. Another scale which is logarithmic is the Richter earthquake magnitude 5 is 32 times stronger (101.5) than a magnitude 4 one. A magnitude 6 earthquake releases 1,000 times (103) more energy than a magnitude 4
one. Logarithms are used in probability theory, e.g. the law of large numbers according to which the ratio of heads to toes during tosses of a fair coin approaches 1/2 as the number of tosses approaches infinity. Some variables have log-normal distributions. The maximum likelihood estimate occurs at the same parameter-value as a maximum of the log
likelihood, and the latter is easier to maximize, especially when there are multiplied likelihoods for independent random variables [1]. The natural logarithm of 2 is used in the formulas for exponential decay. A reminder: to compute the natural log of a
number in this logarithm calculator, simply leave the "Base" field empty. Log calculations occur in fractals, entropy and chaos theory, as well as the analysis of computation complexity of different computer algorithms [2]. They are valuable for describing algorithms in which a larger problem is divided into a set of smaller ones, and then the solutions
of the smaller problems are joined to arrive at the solution of the larger problem. 1 Rose C., Smith M.D (2002) "mathStatica: Mathematical Statistics with Mathem
logarithm / log rules There are a number of logarithm rules, properties, and identities that can be particularly useful for manipulating and solving algebraic expressions or equations. Three basic logarithm rules are the product, quotient, and power rules. Product rule of logarithms can
be expressed as logb(mn) = logb(m) + logb(n) where b is the base and m and n are variables being multiplied. Example Expand: log2(7x) = log2(7x) + log
log 16(5) - log 16(y) Power rule The power rule of logarithms can be expressed as log b(mn) = n \cdot log b(mn) where b is the base and m is being raised to the nth power. Example Expand: log 16(y) Power rule The power rule of logarithm that are used to simplify complex log 16(y) Power rule The power rule The power rule of logarithm rules are the properties or the identities of the logarithm that are used to simplify complex log 16(y) Power rule The power rule The power rule The power rule of logarithm rules are the properties or the identities of the logarithm that are used to simplify complex log 16(y) Power rule The power rule The power rule The power rule of logarithm rules are the properties or the identities of the logarithm rules are the properties or the identities of the logarithm rules are the properties or the identities of the logarithm rules are the properties or the identities of the logarithm rules are the properties or the identities of the logarithm rules are the properties or the identities of the logarithm rules are the properties or the identities of the logarithm rules are the properties or the identities of the logarithm rules are the properties or the identities of the logarithm rules are the properties or the identities of the logarithm rules are the properties or the identities of the logarithm rules are the properties of the logarithm rules are the logarithm rules are the logarithm rules are the properties of the logarithm rules are the loga
expressions and solve logarithmic equations involving variables. They are derived from the exponent rules, as they are just the opposite of writing an exponent rules are used to simplify complex logarithmic equations involving variables. It states that the
\log x = \log x 
\frac{x}{y} = \frac{b}x-\log {b}y For example, \frac{6}\left(\frac{28}{25}\right) Let us assume \frac{b}y For example, \frac{6}\left(\frac{28}{25}\right) Let us assume \frac{b}y For example, \frac{6}\left(\frac{b}y\right) For example, \frac{6}\left(\frac{b}y
\{y\} \Rightarrow \{b^{p-q}=\langle x\}\{y\}\} It states that the logarithm of a number raised to a power is the power times the logarithm of the number.
\log b(xn) = n \log b(
given number 'x' to a base 'b' can be expressed as the ratio of the logarithm of 'x' to any other base 'c.' \{\log_{c}x\}, where 'c' is any other base. Let us assume logb(x)
 \{\log_{c}b\}\ \Rightarrow logbx \cdot logcb = logcx, another form of the rule. It states that: 1. The logarithm of a base raised to a number is that number. \{b^{\k}\ For example, \{8^{\k}\}\ For example, \{8^{\k}\}\ and \{\log_{a}b\}\ and \{\log_{a}b\}\
Let us assume logb(x) = p \dots(i) Converting the logarithm into its exponential form, we get logb(bp) = p Thus, mathematically, it is logb(x) = p \dots(i) Converting the logarithm of 1 to any base is zero. logb(1) = 0 For
example, \log 15(1) = 0, \log 2(1) = 0 Let us consider the logarithmic equation \log b(1) = x Converting into its exponential form, we get bx = 1 \Rightarrow bx = b0 \Rightarrow x = 0 Thus, \log b(1) = x Converting into its exponential form, we get bx = 1 \Rightarrow bx = b0 \Rightarrow x = 0 Thus, \log b(1) = x Converting into its exponential form, we get bx = 1 \Rightarrow bx = b0 \Rightarrow x = 0 Thus, \log b(1) = x Converting into its exponential form, we get bx = 1 \Rightarrow bx = b0 \Rightarrow x = 0 Thus, \log b(1) = x Converting into its exponential form, we get bx = 1 \Rightarrow bx = b0 \Rightarrow x = 0 Thus, \log b(1) = x Converting into its exponential form, we get bx = 1 \Rightarrow bx = b0 \Rightarrow x = 0 Thus, \log b(1) = x Converting into its exponential form, \log b(1) = x Converting into its exponential form, \log b(1) = x Converting into its exponential form, \log b(1) = x Converting into its exponential form, \log b(1) = x Converting into its exponential form, \log b(1) = x Converting into its exponential form, \log b(1) = x Converting into its exponential form, \log b(1) = x Converting into its exponential form, \log b(1) = x Converting into its exponential form, \log b(1) = x Converting into its exponential form, \log b(1) = x Converting into its exponential form, \log b(1) = x Converting into its exponential form, \log b(1) = x Converting into its exponential form, \log b(1) = x Converting into its exponential form, \log b(1) = x Converting into its exponential form, \log b(1) = x Converting into its exponential form, \log b(1) = x Converting into its exponential form, \log b(1) = x Converting into its exponential form, \log b(1) = x Converting into its exponential form, \log b(1) = x Converting into its exponential form, \log b(1) = x Converting into its exponential form, \log b(1) = x Converting into its exponential form, \log b(1) = x Converting into its exponential form, \log b(1) = x Converting into its exponential form, \log b(1) = x Converting into its exponential form, \log b(1) = x Converting into its exponential form, \log b(1) = x Converting into its exponential form, \log b(1) = x Converting into its exponential
exponential form, we get bx = b \Rightarrow bx = b1 \Rightarrow x = 1 Thus, logb(b) = 1 It states that the logarithm of a number's reciprocal is equal to the negative of the logarithm of that number. \{1\} For example, \{1\} is the logarithm of that number. \{1\} is 
\{x\} be the number and its reciprocal. Since \{x\} it states that the natural logarithm (denoted by logf(x)right) = \{b\} it states that the natural logarithm (denoted by logf(x) or \{b\} logf(x) or \{b\} logf(x) it states that the natural logarithm (denoted by logf(x) or \{b\} logf(x) or \{b\} logf(x) it states that the natural logarithm (denoted by logf(x) or \{b\} logf(x) or \{b\} logf(x) it states that the natural logarithm (denoted by logf(x) or \{b\} logf(x) or \{b\} logf(x) or \{b\} logf(x) it states that the natural logarithm (denoted by logf(x) or \{b\} logf(x) or \{
 follows all the above properties of base logarithms. Here are some more special properties of natural logarithm: It states that the derivative of a number with respect to it is equal to \{dx_{x}\} tt states that the integration of \{dx_{x}\} with respect to it is equal to \{dx_{x}\}.
7 \le x+1 \le 
power rule) = \{\log_{5}3+2\log_{5}\} (by the identity rule) for \{5\}3+2\log_{5}\} (by the identity rule) for \{5\}3+2\log_{5}
x+4\right)^{3}}{7\left(x+1\right)} = {1+\log_{5}3-\log_{5}7+2\log_{5}1+\log_{5}7+2\log_{5}1+\log_{5}7+2\log_{5}1+2\log_{5}1+2\log_{5}1+2\log_{5}1+2\log_{5}1+2\log_{5}1+2\log_{5}1+2\log_{5}1+2\log_{5}1+2\log_{5}1+2\log_{5}1+2\log_{5}1+2\log_{5}1+2\log_{5}1+2\log_{5}1+2\log_{5}1+2\log_{5}1+2\log_{5}1+2\log_{5}1+2\log_{5}1+2\log_{5}1+2\log_{5}1+2\log_{5}1+2\log_{5}1+2\log_{5}1+2\log_{5}1+2\log_{5}1+2\log_{5}1+2\log_{5}1+2\log_{5}1+2\log_{5}1+2\log_{5}1+2\log_{5}1+2\log_{5}1+2\log_{5}1+2\log_{5}1+2\log_{5}1+2\log_{5}1+2\log_{5}1+2\log_{5}1+2\log_{5}1+2\log_{5}1+2\log_{5}1+2\log_{5}1+2\log_{5}1+2\log_{5}1+2\log_{5}1+2\log_{5}1+2\log_{5}1+2\log_{5}1+2\log_{5}1+2\log_{5}1+2\log_{5}1+2\log_{5}1+2\log_{5}1+2\log_{5}1+2\log_{5}1+2\log_{5}1+2\log_{5}1+2\log_{5}1+2\log_{5}1+2\log_{5}1+2\log_{5}1+2\log_{5}1+2\log_{5}1+2\log_{5}1+2\log_{5}1+2\log_{5}1+2\log_{5}1+2\log_{5}1+2\log_{5}1+2\log_{5}1+2\log_{5}1+2\log_{5}1+2\log_{5}1+2\log_{5}1+2\log_{5}1+2\log_{5}1+2\log_{5}1+2\log_{5}1+2\log_{5}1+2\log_{5}1+2\log_{5}1+2\log_{5}1+2\log_{5}1+2\log_{5}1+2\log_{5}1+2\log_{5}1+2\log_{5}1+2\log_{5}1+2\log_{5}1+2\log_{5}1+2\log_{5}1+2\log_{5}1+2\log_{5}1+2\log_{5}1+2\log_{5}1+2\log_{5}1+2\log_{5}1+2\log_{5}1+2\log_{5}1+2\log_{5}1+2\log_{5}1+2\log_{5}1+2\log_{5}1+2\log_{5}1+2\log_{5}1+2\log_{5}1+2\log_{5}1+2\log_{5}1+2\log_{5}1+2\log_{5}1+2\log_{5}1+2\log_{5}1+2\log_{5}1+2\log_{5}1+2\log_{5}1+2\log_{5}1+2\log_{5}1+2\log_{5}1+2\log_{5}1+2\log_{5}1+2\log_{5}1+2\log_{5}1+2\log_{5}1+2\log_{5}1+2\log_{5}1+2\log_{5}1+2\log_{5}1+2\log_{5}1+2\log_{5}1+2\log_{5}1+2\log_{5}1+2\log_{5}1+2\log_{5}1+2\log_{5}1+2\log_{5}1+2\log_{5}1+2\log_{5}1+2\log_{5}1+2\log_{5}1+2\log_{5}1+2\log_{5}1+2\log_{5}1+2\log_{5}1+2\log_{5}1+2\log_{5}1+2\log_{5}1+2\log_{5}1+2\log_{5}1+2\log_{5}1+2\log_{5}1+2\log_{5}1+2\log_{5}1+2\log_{5}1+2\log_{5}1+2\log_{5}1+2\log_{5}1+2\log_{5}1+2\log_{5}1+2\log_{5}1+2\log_{5}1+2\log_{5}1+2\log_{5}1+2\log_{5}1+2\log_{5}1+2\log_{5}1+2\log_{5}1+2\log_{5}1+2\log_{5}1+2\log_{5}1+2\log_{5}1+2\log_{5}1+2\log_{5}1+2\log_{5}1+2\log_{5}1+2\log_{5}1+2\log_{5}1+2\log_{5}1+2\log_{5}1+2\log_{5}1+2\log_{5}1+2\log_{5}1+2\log_{5}1+2\log_{5}1+2\log_{5}1+2\log_{5}1+2\log_{5}1+2\log_{5}1+2\log_{5}1+2\log_{5}1+2\log_{5}1+2\log_{5}1+2\log_{5}1+2\log_{5}1+2\log_{5}1+2\log_{5}1+2\log_{5}1+2\log_{5}1+2\log_{5}1+2\log_{5}1+2\log_{5}1+2\log_{5}1+2\log_{5}1+2\log_{5}1+2\log_{5}1+2\log_{5}1+2\log_{5}1+2\log_{5}1+2\log_{5}1+2\log_{5}1+2\log_{5}1+2\log_{5}1+2\log_{5}1+2\log_{5}1+2\log_{5}1+2\log_{5}1+2\log_{5}1+2\log_{5}1+2\log_{5}1+2\log_{5}1+2\log_{5}1+2\log_{5}1+2\log_{5}1+2\log_{5}1+2\log_{5}1+2\log_{5}1+2\log_{5}1+2\log_{5}1+2\log_{5}1+2\log_{5}1+2\log_{5}1+2\log_{5}1+2\log_{5}1+2\log_{5}1+2\log_{5}1+2\log_{5}1+2\log_{5}1+2\log_{5}1+2\log_{5}1+2\log_{5}1+2\log_{5}1+2\log_{5}1+2\log_{5}1+2\log_{5}1+2\log_{5}1+2\log_{5}
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