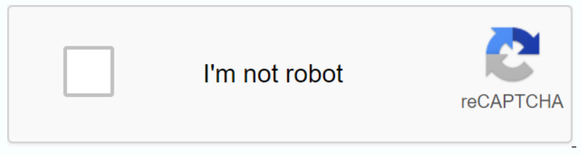

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Logarithmic series pdf

Infinite range of various simple functions of the logarithm include (1) (2) (3) (4) where is the Euler-Mascheroni constant and is the Riemann zeta function. Note that the first two of these are diverse in the classic sense, but converge when interpreted as zeta-realized sums. Mathematica » The #1 for creating Demonstrations and anything technical. Wolfram| Alpha » Explore anything with the first calculation knowledge engine. Tungsram Demonstrations Project » Explore thousands of free programs across science, mathematics, engineering, technology, business, arts, finances, social sciences, and much more. Computerbasedmath.org » Join the initiative for the modernisation of mathematics education. Online Integral Calculator » Solve integrals with Wolfram| Alpha. Step-by-step Solutions » Walk through homework problems step-by-step from start to finish. Tips help you try the next step on your own. Tungsten Problem Generator » Unlimited random practice problems and answers with built-in Step-by-step solutions. Practice online or make a printable study page. Tungsas Education Portal » Collection of teaching and learning tools built by Wolfram education experts: dynamic textbook, lesson plans, widgets, interactive demonstrations, and much more. Tungsram Language » Knowledge-based programming for everyone. 6th CBSE 7th CBSE 8th CBSE 9th CBSE 10th CBSE 11th CBSE 12th CBSE Vedic Logarithm on the basis of the mathematical constant e Bases responses here. For the numbering system that uses e as its base, see Non-integer representation ≥ Base e. Graph of the natural logarithm function. The function slowly grows to increase positive infinity such as x, and slowly after negative infinity goes like x 0 (slowly approaching compared to any power law of x); the y axis is an asscension. Part of a series of articles on thematic constant e Properties Natural Logarithm Exponential Function Applications compiled interest Euler's identity Euler's formula half-life exponential growth and expiration Definition defines proof that e are irrational representations of e Lindemann-Weierstrass theorem People John Napier Leonhard Euler Related topics Schanuel's rejection vth The natural logarithm of a number is his logariths at the base of the mathematical constant e, where e is an irrational and transcendental number equal equal to 2.718281828459. The natural logarithms of x are generally written as ln x, loge x, or sometimes, if the base is implicit, simply draw x.[1][2][3] Parents are sometimes added for clarity, give ln (x), loge(x), or log(x). This is especially done when the argument to the logarithm is not a single symbol, so that prevent ambiguity. The natural logarithms of x are the power to which e will need to be raised to equal x. For example, ln 7.5 is 2.0149..., because e2.0149... = 7.5. The natural logarithm of e itself, ln e, is 1, e1 = e, while the natural logarithm of 1 is 0, since e0 = 1. The natural logarithm can be defined for any positive actual number a area under the curve y = 1/x from 1 to a[4] (with the area negative when 0 < per < 1). matching many other formulas containing the natural logarithm, leads to the term natural. The definition of the natural logarithm can then be expanded to give logarithm values for negative numbers and for all non-zero complex numbers, although this leads to a multi-valued function: see Complex logarithm for more. The natural logarithm function, considered a truly valued function of a truly variable, is the reverse function of the exponential function, resulting in the identities: e ln x = x as x > 0 , ln e x = x . {\display style {\start{alignment}e^{ln x}&=x\qquad {\text{if}}x>0,\\\ln e^{x}&=x.\end{confess}} Like all logarithms, the natural logarithm charts multiplying in additional: LN x y = ln x + ln y . {\display style \ln xy=\ln x+\ln y.} [5] Logarithms can be defined for any positive basis other than 1, not just e. But logarithms in other bases differ only by a constant multiplor of natural logarithms, and can be defined in terms of the latter. For example, the base-2 logarithm (also known as the binary logarithm) is equal to the natural logariths shared by ln 2, the natural logarithm of 2. Logarithms are useful for solving equations in which the unknown appears as the exponent of another quantity. For example, logarithms are used to solve for half-life, expire constant, or unknown time in exponential decay problems. They are important in many branches of mathematics and scientific disciplines, and are used in finance to solve problems with compound interest. The concept of the natural logarithms was worked out by Gregoire de Saint-Vincent and Alphonse Antonio de Sarasa before 1649. [6] Their work has quadrature of the hyperbola compared xy = 1 entailed by determining the area of hyperbolic sectors. Their solution generated the required hyperbolic logarithm function, which the characteristics are now associated with the natural logarits. An early mention of the natural logarithm was published by Nicholas Mercator in his work Logarithmotechnia, published in 1668,[7] although mathematics teacher John Speidell had already compiled a table of what was in fact effective natural logarithms in 1619. It was said that Speidell's logarithms are on the base, but this is not entirely true due to complications with the values expressed as whole numbers. [8]:152 Notational conventions The notations ln x and loge x both refer to the natural logarithm of x, and log x without an explicit basis can also refer to the natural logarithm. [1] This use is common in mathematics, along with some scientific contexts as well as in many programming languages. [nb 1] In some other contexts such as chemistry, log x can however be used to 10) logarithm. It may also refer to the binary (base 2) logarithm in the computer science, especially in the context of time complexity. Definitions ln a as the area of the shady region under the curve f(x) = 1/x from 1 to a. If less than 1, the area became negative. The area under the hyperbola complies with the logarithm rule. Here, A(s,t) indicates the area under the hyperbola between s and t. The natural logarithm can be defined in various equivalent ways. The natural logarithm of a positive, actual number a can be defined as the area under the graph of the hyperbola with equation y = 1/x between x = 1 and x = a. This is the integral part of = ∫ 1 a 1 x d x . {\display style \ln a=\int _{1}^{a}{\frac {1}{x}}\,dx.} If less than 1, this area is considered negative. This function is a logarithm because it complies with the fundamental multiplying property of a logarithm:[5] ln (a b) = ln a + ln b . {\display style \ln(ab)=\ln a+\ln b.} It can be demonstrated by the integrals that define ln ab in two parts, and then making the variable replacement x = by (so dx = a dt) in the second part, as follows: ln a b = ∫ 1 a b 1 x d x = ∫ 1 a 1 x + ∫ a b 1 x d x = ∫ 1 a 1 x d x + ∫ 1 b 1 a d t = ∫ 1 n 1 n 1 x + ∫ 1 b 1 t = ln a + ln b . {\display style {\start{confessed}\ln ab=\int _{1}^{ab}{frac {1}{x}}\,dx&=\int _{1}^{a}{\frac {1} {x}}\,dx+\int _{{a}^{{frac {1}{x}}\,dx\\[5pt]&=\int _{1}^{a}{\frac {1} {x}}\,dx+\int _{1}^{b}{\frac {1}{at}}a\,dt\[5pt]&=\int _{1}^{a}{\frac {1}t {{x}}\,dx+\int_{1}^{b}{\frac {1}{t}}\,dt\[5pt]&=\ln a+\ln b.\end{alignment}}} in elementary terms, it is simply scale through 1/a in the horizontal direction and by an in the vertical direction. Area does not change under this transformation, but the region between a and ab has been reconfigured. Because the function a/(axe) equals the function 1/x, the resulting area is precisely ln b. The number e can then be defined to be the unique actual number of such a one that ln a = 1. Alternatively, if the exponential function, evening ex of exp x, is first defined, say by using an infinite range, then the natural logarithm can be defined as its reverse function. In other words, ln is that function such that ln (exp x) = x. Since the scope of the exponential function is all positive real numbers, and since the exponential function is strictly increasing, it is well defined for all positive x. Properties ln 1 = 0 {\displaystyle \ln 1=0} ln e = 1 {\displaystyle\ln e=1} ln (x y) = ln x + l y for x > 0 and y > 0 {\displaystyle \ln(xy)=\ln x+\ln y\quad {\text{{for }}\;x>0\;{ {text{and }}\;y>0} ln (x y) = y ln x for x > 0 {\display style \ln(x^{y})=y\ln x\quad {\text{{{{{{{;x>0} l x < ln= = y= for= 0=> < x=> < y= {\displaystyle= \ln=> <\ln y\quad= {\text{for=></\ln> <> <y} lim= x= →= 0= ln= = (=1= += x= x== \lim= _{x\to= 0}{\frac= {\ln(1+x)}{x}}=1} lim= α= →= 0= x= α= −= 1= α=ln = x= for= x=>0 {\displaystyle \lim _{\alpha \om 0}{\frac= {x^{\alpha }-1}{\alpha}}=\ln x\quad {\teks{vir }}\;x>0} x - 1 x ≤ ln </y> </y}> ≤ x - 1 vir x > 0 {\displaystyle {\frac {x-1}}}}\leq \ln x\leq x-1\quad {\teks{for}}\quad x>0} ln (1 + x α) ≤ α x vir x ≥ 0 en α ≥ 1 {\displaystyle \ln {(1+x^{\alpha})}\leq \alfa x\quad {\teks{{vir}}\quad x\geq 0\;{ \teks{en }}\;\alfa \geq 1} Bewys Die stelling is waar vir x = 0 {\vertoonstyl x=0} , en ons wys nou dat d x ln (1 + x α) ≤ d x (α x) {\vertoonstyl {\vertoon \frac {d}{dx}}\ln {(1+x^{\alpha})}\leq {\frac{d}{dx}}(\alpha x)} vir alle x {\displaystyle x} , wat die bewys voltooi deur die fundamentele teorema van calculus. Vandaar, ons wil wys dat d x ln (1 + x α) = α x α - 1 1 + x α ≤ α = d d x (α x) {\vertoonstyl {\frac{d}{dx}}\ln {(1+x^{{\alfa}}}}={\frac {\alpha x^{\alfa -1}}}{1+x^{\alpha}}}}\leq \alpha ={\frac{d}{dx}}(\alpha x)} (Let daarop dat ons nog nie bewys het dat hierdie stelling waar is nie.) As dit waar is, dan deur die middelste verklaring te vermenigvuldig deur die positiewe hoeveelheid (1 + x α) / α {\displaystyle (1+x^ {\alpha })/\alfa } en aftrek x α +\displaystyle x ^{\alpha}} sal ons x α verkry - 1 ≤ x α + 1 \vertoonstyl x ^{\alpha -1}\leq x^{\alpha }+1} x α - 1 (1 - x) ≤ 1 {\vertoonstyl x^{\alpha -1}(1-x)\leq 1} Hierdie stelling is triviaal waar vir x ≥ 1 {\displaystyle x\geq 1} aangesien die linkerkant is Vir 0 ≤ x < 1= {\displaystyle= 0\leq=> <1} it= is= still= true= since= both= factors= on= the= left= are= less= than= 1= (recall= that= α= ≥= 1= {\displaystyle= \alpha= \geq= 1}=).= thus= this= last= statement= is= true= and= by= repeating= our= steps= in= reverse= order= we= find= that= d= d= x= ln= = (= 1= += x= α=)= ≤= d= d= x= (= α= x=)= {\displaystyle= {\frac= {d}{dx}}\ln= {(1+x^{\alpha= })}\leq= {\frac= {d}{dx}}(\alpha= x)}= for= all= x= {\displaystyle= x}= .= this= completes= the= proof.= an= alternate= proof= is= to= observe= that= (= 1= += x= α=)= ≤= (= 1= += x=)= α= {\displaystyle= (1+x^{\alpha= })\leq= (1+x)^{\alpha= }}= under= the= given= conditions.= this= can= be= proved,= e.g.,= by= the= norm= inequalities.= taking= logarithms= and= using= ln= = (= 1= += x=)= ≤= x= {\displaystyle= \ln(1+x)\leq= x}= completes= the= proof.= derivative= the= derivative= of= the= natural= logarithm= as= a= real-valued= function= on= the= positive= reals= is= given= by[4]= d= d= x= ln= = x=1 x= .= {\displaystyle= {\frac= {d}{dx}}\ln= x={\frac {1}{x}}.} = how= to= establish= this= derivative= of= the= natural= depends= on= how= it= is= defined= firsthand.= if= the= natural= logarithm= is= defined= as= the= integral= ln= = x=∫ 1= x= 1= t= d= t= ,= {\displaystyle= \ln= x=\int _{1}^{x}{\frac= {1}{t}}\,dt,}= then= the= derivative= immediately= follows= from= the= first= part= of= the= fundamental= theorem= of= calculus.= on= the= other= hand,= if= the= natural= logarithm= is= defined= as= the= inverse= of= the= (natural)= exponential= function,= then= the= derivative= (for= x=>0) kan gevind word deur die gebruik van die eienskappe van die logaritm en 'n definisie van die eksponensiële funksie. Vanaf die definisie van die nommer e = lim u → 0 (1 + u) 1 / u , {\displaystyle e=\lim _{u\na 0}(1+u)^{1/u},} die eksponensiële funksie kan gedefinieer word as e x = lim u → 0 (1 + u) x / u = lim h → 0 (1 + h x) 1 / h {\displaystyle</1}> {\displaystyle</1}> _{u\na 0}(1+u)^{x/u}=\lim _{h\na 0}(1+hx)^{1/h}} } , where you =h x , h = u /x . {\display style u=hx,h=u/x.} The derivative can then be found from the first principles. d x ln x = lim h → 0 ln (x +h) - ln x h = lim h = lim h → 0 [1 h ln (x+ h x)] = lim h → 0 [ln (1+ h x) 1 h] all above for logar ltymic properties = ln [lim h → 0(1+h x) 1 h] for continuity of the logarithm = ln e 1/ x for the definition of e x = lim → 0 (1+h x) 1/ h = 1 x for the definition of the ln axis reverse function. {\display style {\start{alignment}{\frac {d}{dx}}\ln x&=\lim _{h\na 0}{\frac {\ln(x+h)-\ln x}}\&=\lim _{h\na 0}\links[{frac {1}{h}}}}l \left ({\frac {x+h}}}\right)\right]\\\\[lim_{h\to 0}\left[\ln \left(1+{\frac {h}{x}}\right)\{{frac {1}{h}}\right]\quad &&{ \text{all above for logarithmic properties}}}\>=\ln \left[\lim _{h\to 0}\left (1+{\frac {h}{x}}}\right)^{\frac {1}{h}}\right]\quad &&> {{{text{for continuity of the logarithm}\>1/x}\quad &&; {\text{for the definition of }}e^{x}=\lim _{h\to 0}(1+hx)^{1/h}\\&={\frac {1}{x}}\quad &&> {\text{for definition of the ln as reverse function.}} \end{aligned}}} Series The Taylor polynom for ln (1+ x) provides only accurate additions in the range -1 < x ≤ 1. Besides some x > 1, the Taylor Polynom of higher grades is increasingly worse. As | x - 1 | ≤ 1 and x ≠ 0 , {\displaystyle \vert x-1\vert \leq 1{\text{ and }}xeq 0,} then[9] ln x = ∫ 1 x 1 t t = ∫ 0 x - 1 1 1+ u d you = ∫ 0 x = ∫ 0 x - 1 1 1+ u d u = ∫ 0 x = ∫ 0 x = ∫ 0 x - 1 1 1+ u d u = ∫ 0 x = ∫ 0 x = ∫ 0 x - 1 1 1 + u d u = ∫ 0 x = ∫ 0 x - 1 1 1+ u d u = ∫ 0 x = ∫ 0 x - 1 1 1+ u d u =∫ 0 x = ∫ 0 x - 1 1 - u+u+ u+ u 2 - your 3+ ⋯) d you = (x - 1) - (x -1) 2+(x - 1) 3 3 - (x - 1) 4 + ⋯ = ∑ k = 1 ∞(-- 1) k - 1 k - 1(x - 1) k. {\display style {\start{alignment}\ln x&=\int _{1}^{{{{frac {1}{t}},dt=\int _{0}^{x-1}{\frac {1} int_1+u}}\,du\\\int_{0}^{x-1}(1-u+u+u^{2}-u^{3}+\cdots)\,du\\&=(x-1)-{\frac {(x- 1)^{2}}{2}}+{\frac {(x-1)^{3}}{3}}-{\frac {(x-1)^{4}}{4}}+\cdots \\>\sum _{k=1}^{\infection }{\frac {(-1)^{k-1}(x-1)^{k}}.\end{confessed}}} It is the Taylor series for ln x around 1. Changing variables delivers the Mercator series: ln (1+x) = ∑ k = 1 ∞(-1)k - 1 k x k = x - x 2 + x 3 - ⋯, {\displaystyle \ln (1+x) =sum _{{k=1}^{\}{\frac {(-1)^{k-1}}{k}}x^{k}=x-{\frac {x^{2}}{2}}+{{{frac {x^{3} {3}}-{3}}\cdots,} valid for |x| ≤ 1 and x ≠ -1. Leonhard Euler,[10] disregards x ≠ - 1 {\display style xeq -1} , nevertheless applied this range to x = -1, to show that the harmonic range equals the (natural) logarithm of 1/(1 - 1), that is, the logarithm of infinity. Nowadays, more formal, one can prove that the harmonic series cut down at N is close to the logarithm of N, when N is great, with the difference that converges to the Constant. Right is a picture of ln (1+ x) and some of his Taylor polynom around 0. These approaches only converge to the function in the region -1 < x ≤ 1; outside this region, the higher grade Taylor polynomial develops to worsen worse appropriations for the function. A useful special case for positive positive n, taking x = 1 n {\displaystyle x={\tfrac {1}{n}}} , is: ln (n + 1 n) = ∑ k = 1 ∞ (− 1) k − 1 k n k = 1 n − 1 2 n 2 + 1 3 n 3 − 1 4 n 4 + ⋯ {\displaystyle \ln \left({\frac {n+1}{n}}\right)=\sum _{k=1}^{\infty }{\frac {(-1)^{k-1}}{kn^{k}}}={\frac {1}{n}}-{\frac {1}{2n^{2}}}+{\frac {1}{3n^{3}}}-{\frac {1}{4n^{4}}}+\cdots } If Re (x) ≥ 1 / 2 , {\displaystyle \operatorname {Re} (x)\geq 1/2,} then ln (x) = − ln (1 x) = − ∑ k = 1 ∞ (− 1) k − 1 (1 x − 1) k k = ∑ k = 1 ∞ (x − 1) k k x k = x − 1 x + (x − 1) 2 2 x 2 + (x − 1) 3 3 x 3 + (x − 1) 4 4 x 4 + ⋯ {\displaystyle {\begin{aligned}\ln(x)&=-\ln \left({\frac {1}{x}}\ right)=-\ sum _{k=1}^{\infty }{\frac {(-1)^{k-1}({\frac {1}{x}}-1)^{k}}{k}}=\sum _{k=1}^{\infty }{\frac {(x-1)^{k}}{kx^{k}}}\\&={\frac {x-1}{x}}+{\frac {(x-1)^{2}}{2x^{2}}}+{\frac {(x-1)^{3}}{3x^{3}}}+{\frac {(x-1)^{4}}{4x^{4}}}+\cdots \end{aligned}}} Now, taking x = n + 1 n {\displaystyle x={\tfrac {n+1}{n}}} for positive integers n, we get: ln (n + 1 n) = ∑ k = 1 ∞ 1 k (n + 1) k = 1 n + 1 + 1 2 (n + 1) 2 + 1 3 (n + 1) 3 + 1 4 (n + 1) 4 + ⋯ {\displaystyle \ln \left({\frac {n+1}{n}}\right)=\sum _{k=1}^{\infty }{\frac {1}{k(n+1)^{k}}}={\frac {1}{n+1}}+{\frac {1}{2(n+1)^{2}}}+{\frac {1}{3(n+1)^{3}}}+{\frac {1}{4(n+1)^{4}}}+\cdots } If Re (x) ≥ 0 and x ≠ 0 , {\displaystyle \operateurnaam {Re} (x)\geq 0\{\teks{ en }}xeq 0,} dan ln (x) = ln (2 x 2) = ln (1 + x - 1 x + 1 1 - x - 1 x + 1) = ln (1 + x - 1 x + 1) - ln (1 - x - 1 x + 1) . {\vertoonstyl \ln(x)=\ln \links({\frac{2x}{2}}\right)=\ln \links({\frac{1+{\frac {x-1}{x+1}}}}{1-{\frac{x-1}{x+1}}}}\regs)=\ln \links(1+{\frac {x-1}{x+1}}\right)-\ln \left(1-{\frac{x-1}{x+1}}\right).} Since ln (1 + y) − ln (1 − y) = ∑ i = 1 ∞ 1 i ((− 1) i − 1 y i − (− 1) i − 1 (− y) i) = ∑ i = 1 ∞ y i i ((− 1) i − 1 + 1) = y ∑ i = 1 ∞ y i − 1 i ((− 1) i − 1 + 1) = i − 1 → 2 k 2 y ∑ k = 0 ∞ y 2 k 2 k + 1 , {\displaystyle {\begin{aligned}\ln(1+y)-\ln(1-y)&=\sum _{i=1}^{\infty }{\frac {1}{i}}\left((-1)^{i-1}y^{i}-(-1)^{i-1}(-y)^{i}\right)=\sum _{i=1}^{\infty }{\frac {y^{i}}{i}}\left((-1)^{i-1}+1\right)\\&=y\sum _{i=1}^{\infty }{\frac {y^{i-1}}{i}}\left((-1)^{i-1}+1\right){\overset {i-1\to 2k}{=}}\;2y\sum _{k=0}^{\infty }{\frac {y^{2k}}{2k+1}} ,\end{aligned}}} kom ons by ln (x) = 2 (x - 1) x + 1 ∑ k = 0 ∞ 1 2 k + 1 ((x - 1) 2 (x + 1) 2) k = 2 (x - 1) x + 1 (1 1 + 1 3 (x - 1) 2 (x + 1) 2 + 1) 2 + 1 ((x - 1) 2 (x + 1) 2) 2 + ⋯) . {\vertoonstyl {\begin{belyn}\ln(x)&={\frac {2(x-1)}{x+1}}\som _{k=0}^{\infty }{\frac {1}{{frac {1}{{frac {1}{{frac 2k+1}}\links({\frac{(x-1)^{2}}{(x+1)^{2}}}\regter)}^{k}\\&={\frac{2(x-1)}{x+1}}\links ({\frac {1}{1}}+{\frac {1}{3}}{\frac {(x-1)^{2}}{(x+1)^{2}}}+{\frac {1}{5}}{\links ({\frac {(x-1)^{2}}{(x+1)^{2}}}\right)}^{2}+\cdots \regs).\einde{aligned}}} Gebruik die vervanging x = n + 1 n {\vertoonstyl x={\tfrac {n+1}{n}}} weer vir positiewe ingeboestuur n, kry ln (n + 1 n) = 2 n + 1 ∑ k = 0 ∞ 1 (2 k k 1) ((2 n +1)2) k = 2(1 2 n + 1+ 1 3 (2 n+1) 3+1 5 (2 n+1) 5 + ⋯) . {\display style {\start{confessed}\ln \left({\frac{n+1}{}\right)&;={{\frac {2}{2n+1}}\sum _{{0}^{{\infection }{{frac {1}{(2k+1)((2n+1)^{2})^^^{k}}\\\\\\>=2\left({\frac {1}{2n+1}}+{\frac {1}{3(2n+1)^{3}}}}}}frac {1}{5(2n+1)^{5}}\cdots \right).\end{alignment}}} It is, by far the fastest converge of the series described here. The natural logarithm in integration The natural logarithm can be simple integration of functions of the form g(x) = f '(x) / f(x): an antiderivative of g (x) given by ln (|f(x)|). This is the case due to the chain rule and the following fact: d x ln | x | = 1 x . {\display style {\frac {d}{dx}}\ln \left|x\right|={\frac {1}{x}}.} In other words, ∫ 1 x d x = ln | x | + C {\displaystyle\int {\frac {1}{x}}\,dx=\ln |x|+C} and ∫ f′ (x) f (x) d x = ln | f (x) | + C . {\display style \int {{\frac {f'(x)}{f(x)}}\,dx}=\ln |f(x)|+C.} Here is an example in case of g(x) = tan(x): ∫ tan x x = ∫ probe x food x ∫ tan x x = ∫ - d x food x food x x x . {\display style {\start{confessed}>\int \tan x\,dx=\int {\frac{\sin x}{\cos x}}\,dx\[6pt]&in \tan x\,dx=\int {\frac {-{\frac{d}{d}}\food x}{cos x}}\,dx.\end{align}} Late f(x) = food (x): ∫ tan x d x = - ln | Food x | + C {\displaystyle \int \tan x\,dx=-\ln \left|\cos x\judge|+C} ∫ tan x d x = ln | Sec x | + C {\displaystyle \int \tan x\,dx=\ln \left|\sec x\reg|+C} where C is an arbitrary constant of integration. The natural logarithm can be integrated using integration by parts: ∫ LN x d x = x ln x - x + C . {\display style \int \ln x\,dx=x\ln x-x+C.} Laat: u = ln x ⇒ d u = d x x {\displaystyle u=\ln x\Rightarrow du={\frac{dx}{x}}} d v = d x ⇒ v = x {\displaystyle dv =dx\Rightarrow v=x} dan: ∫ ln x d x = x ln x - ∫ x x x = x ln x - ∫ 1 d x = x ln x - x + C {\vertoonstyl {\begin{belyn}\int \ln x\,dx&=x\ln x-\int {\frac{x}{x}}\,dx\\&=x\ln x-\int 1\,dx\&amp=x\ln x-x+C\end{aligned}}} Numeriese waarde Vir ln(x) waar x > 1 >, hoe nader is die waarde van x na 1, hoe vinniger die tempo van konvergensie. The identities associated with the logariths, can be used to exploit it: ln 123.456 = ln (1.23456 – 10 2) = ln 1.23456 + ln (10 2) = ln 1.23456 + 2 ln 10 ≈ ln 1.23456 + 2 . 2.3025851. {\display style {\start{alignment}\ln 123.456&=\ln(1.23456\cdot 10^{2})\&=\ln 1.23456 +\ln (10^^ {2})&=\ln 1.23456 +\ln (10^^ {2})&=\ln 1.23456 +\ln (10^^ {2})&;=\ln 1.23456 +\ln (10^^ {2})&==\ln 1.23456 +\ln (10^^ {2})&=\ln 1.23456 +\ln (10^^ {2})&=\ln 1.23456 +\ln (10^^ {2} =\ln 1.23456+2\ln 10\\> approx \ln 1.23456+2\cdot 2.3025851.\end{alignment}}} Such techniques were used before calculators, by referring to numeric tables and performing manipulations such as those above. Natural Logarithm of 10 The Natural of 10, for example, the decimal extension 2.30258509...,[11] plays a role for example in calculating natural logarithms of numbers represented in scientific notation, as a mantissa multiplied by a power of 10: ln (a 10 n) = ln a + a ln 10. {\display style \ln(a\cdot 10^{n})=\ln a+n\ln 10.} These These that one can effectively calculate the logarithms of numbers with very large or very small size using the logarithms of a relatively small set of decimals in the range [1 , 10) {\display styles [1,10)}. High accuracy to calculate the natural logarithm with many digits of precision, the Taylor series approach is not effective as the convergence is slow. Especially if x is near 1, a good alternative is to use Halley's method or Newton's method to reverse the exponential function, because the range of the exponential function gathers more quickly. For finding the value of y to give exp (y) − x = 0 using Halley's method, or equivalent to exp (y/2) - x exp (-y/2) = 0 using Newton's method, the iteration simplified to y n +1 = y n + 2 - exp (y n) x + exp (y n) {\display style y_{n + 1}=y_ y_ {n}+2\cdot {\frac{x-\exp(y_{n})}{x+\exp(y_{n})}} which has cubic convergence with Ln(x). Another alternative to extremely high accuracy calculation is the formula[12] ln x ≈ π 2 M (1, 4/s) - m ln 2 , {\displaystyle \ln x \approximate {\frac {\pi}{2M (1,4/s)}}-m \ln 2, where M is the arithmetic average of 1 and 4/s evening sign, and s = x 2 m > 2 p/2 , {\display style s=x2^{m}>2^{p/2},} are selected with m so that p bits of precision are achieved. (For most purposes, the value of 8 for m is sufficient.) In fact, if this method is used, Newton inversion of the natural logarithm can be used vice versa to calculate the exponential function efficiently. (The constant ln 2 and π can be pre-calculated to the desired precision using any of several known quick conversation series.) Based on a proposal by William Kahan and first implemented in the Hewlett-Packard HP-41C calculator in 1979 (refer to under LN1 in the show, only some calculators, operating systems (for example Berkeley UNIX 4.3BSD[14]), computer brazen systems and programming languages (for example, C99[15]) provide a special natural logarithm plus 1 function, alternatively called LNP1,[16][17] or log1p[15] to return more accurate results for logarithms close to zero by arguments x, also close to zero, to a function log1p(x), which gives back the value (1+x), instead of passing back a value value close to 1 to a function (y). [15] [16] [17] The function log1p avoided in the floating point retmetic a near cancellation of the absolute term 1 with the second quarter of the Taylor extension of the Ln, allowing it to have a high accuracy for both the argument and the result near zero. [17] In addition to the base of the IEEE 754-2008 standard, similar logarithmic functions define near 1 for binary and decimal logarithms: log 2 <8> (1+x) {\displaystyles \log _{2}(1+x)} and draw 10 (1+ x) {\displaystyles \log _{10}(1+x)} . Similar reverse functions called expm1,[15] expm[16][17] or exp1m also exist, all with the meaning of = exp (x) - 1. [nb 2] 'An identity in terme of that inverted hiperboliese tangent, l o g 1 p (x) = log (1 + x) = 2 'n r t n h (x 2 + x), , \mathrm {log1p} (x)=\log(1+x)=2~\mathrm {artanh} \left({\frac{x}{2+x}}\right)\,} gives a high precision value for small values of x on systems that do not implement log1p (x). Main article: Commerce complexity of mathematical operations The calculation complexity of the calculation complexity of calculating the natural logarithme (using the arithmetic geometric average) is O(M(n) ln). Here is the number of digits of precision at which the natural logarithm must be evaluated and M(n) is the calculation complexity of multiplying two n-digit numbers. Continued fractions While no simple continued fractions are available, several common continued fractions are, Including: ln (1+x) = x 1 1 - x 2 2+ x 3 3 - x 4 + x 5 5 - ⋯ = x 1 - 0 x + 1 2 x 2 - 1 x + 2 2 2 x 3 - 2 x + 3 3 2 x 4 - 3 x + 4 2 x 5 - 4 x + ⋱. {\display style {\start{confessed}\ln (1+x)&={\frac {x^{1}}} 1}}-{\frac {x^{2}}{2}}+\ frac {x^{3}}-{3}}-{\frac {x^{4}}{4}}+{{frac{x^{5}}-{5}}-cdot \[5pt]&={\cfrac{x }{1-0x+{cfrac {1^{2}x}{2-1x+{\cfrac {2^{2}x}{3-2x+{cfrac {3^{2}x}{4 -3x+{\cfrac {4^{2}x}{5-4x+\ddots }}}}}}}}}}}}}}}}{end{aligned}}}ln (1+ x y) = x y + 1 x 2+ 1 x 3 y + 2 x 2 x 5 + 3 x 2 + ⋱. = 2 x 2 y + x - (1 x) 2 3 (2 y + x) ((2 x) 2 5 (2 y + x) - (3 x) 2 7 (2 y + x) ⋱. {\display styles {\start{aligned}\ln \left (1+ {{\frac {x}{y}}\right)> {\cfrac {x}{{y+{cfrac {1x}{2+{cfrac {1x}{3y+{cfrac {2x}{2+{cfrac {2x}{5y+{cfrac {2x}{cfrac {2x}{cfrac{cfrac{c 2x}{{{cfrac {2x}{{cfrac {2x}{{{cfrac {2x}{{cfrac {2x}{cfrac {rac {2x}{{cfrac {2x}{cfrac {2x}{cfrac {2x}3x}{2+\ddots }}}}}}}}}}[5pt]&={\cfrac {2x}{2y+x-{cfrac {(1x)^{2}}{3(2y+x)-{cfrac {(2x)^{2}}{5(2y+x)-{\cfrac {(3x)^{2}}{7(2y+x)-\ddots }}}}}}}}}\end{aligned}}} These sustained fractions — especially the last -converge quickly for values close to 1. However, the natural logarithms of much larger numbers can be easily calculated by adding repeatedly those of smaller numbers, with similar rapid convergence. For example, since 2 = 1.253 × 1.024, the natural logarithme of 2 can be calculated as: ln 2 = 3 ln (1+1 4) + ln (1+3 125) = 6 9 -1 11 2 27 - 2 2 45 - 3 2 63 ⋱. +6 253 - 3 2 759 - 6 2 1265 - 9 2 1771 ⋱.. {\display style {\start{alignment}\ln 2&=3\ln \left (1+{\frac {1}{4}}\right)+\ln \left(1+{\frac {3}{125}}\right)\\\[8pt]&{ \cfrac {6}{9-{\cfrac {1^{2}}{27-{cfrac {2^{2}}{45-{\c {3^{2}}{63-\ddots}}}}}}}{\cfrac {6}{253-{\cfrac {3^{2}}{759-{{{{{{{{cfrac {6^{2}}{1265-{cfrac {9^{2}}{1771-\ddots }}}}}.\end{align}}} Furtherover, since 10 = 1.2510 × 1.0243, even the natural logarithm of 10 can be similarly calculated as: ln 10 = 10 ln (1+1 4) + 3 ln (1+3 125) = 20 9 − 1 2 27 - 2 2 45 - 3 2 63 ⋱. + 18 253 - 3 2 759 - 6 2,1265 - 9 2 1771 ⋱. . {\display style {\start{alignment}\ln 10&=10\ln \left (1+{\frac {1}{4}}\right)+3\ln {3} {125}} \right)\\[10pt]&; {\cfrac {20}{9-{\cfrac {1^{2}}{27-{cfrac {2^{2}}{45-{\cfrac {3^{2}}{63-\ddots}}}}}} } } {\cfrac {18}{253-{\cfrac {3^{2}}{759-{\cfrac {6^{2}}{1265-{cfrac {9^{2}}{1771-\ddots }}}}.. \end{align}}} Complex logarithms Main article: Complex logarithm The The function can be extended to a function that gives a complex number as ex for any arbitrary complex number x; Simply use the infinite range with x complex. This exponential function can be reversed to form a complex logarithm that displays most of the characteristics of the usual logarithm. There are two problems involved: no x has ex = 0; and it turns out that e2αi = 1 = e0. Since the multiplying property continues to work for the complex exponential function, ez = ez + 2μki, for all complex z and whole numbers k. So the logarithm cannot be defined for the entire complex aircraft, and even then it is multi-valued — any complex logarithm can be turned into an equivalent logarithm by adding any integer multiple of 2019. The complex logarithm can only be single valued on the cutting aircraft. For example, ln(i) = αi/2 or 5αi/2 or -3μi/2, etc.; and although i4 = 1, 4 log(i) can be defined as 2019 or 100i or -60i, and so on. Plots of the natural logarithm function on the complex plane (principal branch) z = Re(ln(x + yi)) z = abs(Im(ln(x + yi))) z = abs(ln(x + yi)) Superposition of the previous three graphs See also Approximating natural exponents (log base e) Iterated logarithm Napierian logarithm List of logarithmic identities Logarithm of a matrix Logarithmic differentiation Logarithmic integral function Nicholas Mercator – first to use the term natural logarithm Polylogarithm Von Mangoldt function Notes ^ Including C, C++, SAS, MATLAB, Mathematica, Fortran, and some BASIC dialects ^ For a similar approach to reduce round-off errors of calculations for certain input values see trigonometric functions like versine, vercosine, coversine, covercosine, haversine, havercosine, hacoversine, hacovercosine, exsecant and excosecant. References ^ a b Compendium of Mathematical Symbols. Mathematics Safe. 2020-03-01. Retrieved 2020-08-29. ^ G.H. Hardy and E.M. 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