

# E (Number) Encyclopedia Article

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# Contents

E (Number) Encyclopedia Article.....	1
Contents.....	2
E (Number).....	3



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The number  $e$ , like the number **pi**, is a useful mathematical constant that is the basis of the system of natural **logarithms**. Its value correct to nine places is 2.718281828... The number  $e$  is used in complex **equations** to describe a process of growth or decay. It is therefore utilized in the biology, business, demographics, physics, and engineering fields.

The number  $e$  is widely used as the base in the exponential function  $y = Ce^{kx}$ . There are extensive tables for  $e^x$ , and scientific calculators usually include an  $e^x$  key. In **calculus** one finds that the **slope** of the graph of  $e^x$  at any point is equal to  $e^x$  itself, and that the integral of  $e^x$  is also  $e^x$  plus a constant.

**Exponential functions** based on  $e$  are also closely related to sines, cosines, hyperbolic sines, and hyperbolic cosines:  $e^{ix} = \cos x + i\sin x$ ; and  $e^x = \cosh x + \sinh x$ . Here  $i$  is the imaginary number  $-1$ . From the first of these relationships one can obtain the curious equation  $e^i + 1 = 0$ , which combines five of the most important constants in mathematics.

The constant  $e$  appears in many other formulae in **statistics**, science, and elsewhere. It is the base for natural (as opposed to common) logarithms. That is, if  $e^x = y$ , then  $x = \ln y$ . ( $\ln x$  is the symbol for the natural logarithm of  $x$ .)  $\ln x$  and  $e^x$  are therefore **inverse functions**.

The expression  $(1 + 1/n)^n$  approaches the number  $e$  more and more closely as  $n$  is replaced with larger and larger values. For example, when  $n$  is replaced in turn with the values 1, 10, 100, and 1000, the expression takes on the values 2, 2.59..., 2.70..., and 2.717....

Calculating a decimal approximation for  $e$  by means of this **definition** requires one to use very large values of  $n$ , and the equations can become quite complex. A much easier way is to use the Maclaurin series for  $e^x$ :  $e^x = 1 + x/1! + x^2/2! + x^3/3! + x^4/4! + \dots$ . By letting  $x$  equal 1 in this series one gets  $e = 1 + 1/1 + 1/2 + 1/6 + 1/24 + 1/120 + \dots$ . The first seven terms will yield a three-place approximation; the first twelve will yield nine places.