Logarithm

Many students when using logarithms, only memorize the rules, without fully understanding their concept. The basic concept of logarithms can be expressed as a shortcut.

Multiplication is a shortcut for Addition: 3 x 5 means 5 + 5 + 5

Exponents are a shortcut for Multiplication: 4^3 means 4 x 4 x 4

Logarithms are a shortcut for Exponents: 10^2 = 100

The present definition of the logarithm is the exponent or power to which a stated number, called the base, is raised to yield a specific number.

The logarithm of 100 to the base 10 is 2 This is written: log 10 100 = 2

Many people throughout time have been accredited with the production and development of logarithms. However, there is one man who is responsible for the invention of the logarithm. That man is the Scotsman, John Napier. Napier is placed within a short lineage of mathematical thinkers beginning with Archimedes and more recent geniuses, Sir Isaac Newton and Albert Einstein.

Napier, who is credited with the invention of logarithms, only considered the study of mathematics as a hobby. Napier's discussion of logarithms appears in his Minifici Logarithmorum Canonis Descriptio (1614). Unlike the logarithms used today, Napier's original logarithms are to base 1/e and involve a constant (10^7). Napier defined his logarithms as a ratio of two distances in a geometric form, as opposed to the current definition of logarithms as exponents. What was Napier's purpose for inventing this system? He developed this shortcut to save astronomers time and limit "slippery errors"

Short bio of John Napier

John Napier was born in the Tower of Merciston, which is now at the center of Napier University's Merchiston campus, in 1550. At the age of 13, he went to St. Andrews studying at St. Salvator's College for two years but failed to obtain a degree. It is thought that he traveled throughout Europe of calculations. His idea was that by "shortening the labours, doubled the life of the astronomer." With his logarithms, Napier presented a mechanical means of simplifying calculations in his Rabdologiae in 1617. He described a method of multiplication using rods with numbers marked off on them. This was the earliest form of mechanical calculation and the forerunner of our modern day calculator.

Napier not only "invented" logarithms, he had many other achievements in his lifetime. Among these accomplishments were revolutionary methods for tilling and fertilizing soil and a number of "Secret Inventions" to defend his country from Philip of Spain. These inventions include the round chariot with firepower and heavy protection (the idea behind the tank); an underwater ship (the submarine); and an artillery piece which would mow down a field of soldiers (the machine gun). It is rumored that while testing his machine gun, he took out an entire flock of sheep in a pasture outside of his estate. After witnessing the destructive power his invention possessed, he swore never to make another gun or give the information on how to make one to anyone.

between 1566-1571, making extended stays in Paris and Holland. In 1571, Napier returned to Scotland and devoted himself to running his estate and participating in the religious controversies of the time. He was a fervent Protestant and published, what he considered his most important contribution to society, the Plaine Discovery of the Whole Revelation of St. John (1593). This is an explanatory work on the Book of Revelation which has intrigued scholars throughout the history of Christianity. Napier believed that the symbols the Book contained were mathematical so they must be able to be disclosed through reason. He regarded this work as so important that it was his only work written in English.

John Napier invented logarithms, but many other scientists and mathematicians helped develop Napier’s logarithms to the system we use today. The first table of common logarithms was compiled by the English mathematician Henry Briggs. In 1624, while working with Napier, Briggs and Napier discovered natural logarithms which first arose as more or less "accidental variations" of Napier’s original logarithms. The possibility of defining logarithms as exponents was recognized by John Wallis in 1685 and later by Johann Bernoulli in 1694.

The invention of logarithms was foreshadowed by the comparison of arithmetic and geometric series. In the simple table used above, the top line is a geometric series and the bottom line is an arithmetic series.

The first table based on this concept was published in 1620 in Prague by Joost Bürgi.

The comparison between the two series was not based on any explicit use of the exponential notation; this was a later development.John Napier, the Scottish mathematician, published his discovery of logarithms in 1614. His purpose was to assist in the multiplication of quantities that were then called sines. The whole sine was the value of the side of a right angled triangle with a large hypotenuse, say 10^7 units long. His definition was given in terms of relative rates. The logarithm, therefore, of any sine is a number very neerely expressing the line which increased equally in the meene time whiles the line of the whole sine decreased proportionally into that sine, both motions being equal timed and the beginning equally shift.

In modern terminology, *L* is the logarithm and *X* the sine. (In modern notation *X* would be *r* sin .)

Thus, with modern techniques derivatives can be used (see Box 10, item 73). At *t* = 0, *X* = *r* (= 90ē), and, since the motion is "equally swift" at the beginning, *a* = *br*. Furthermore, the function *L* is known to have certain values at specific points (see Box 10, item 74). Thus in terms of present logarithms to the base *e* the function *L* can be expressed in terms of natural logarithms (see Box 10, item 75). Napier's value of *r* was 10^7. This expression does not have the expected property for *L*(*XY*), but the relationship involving products and division (see Box 10, item 76) does apply.

In cooperation with the English mathematician Henry Briggs, Napier did adjust his logarithms into the form in which it is usually found. For the modern Naperian logarithm (*i.e.,* the logarithm to the base *e*) the comparison would be between points moving on two straight lines, marked in units of length, the *L* point moving uniformly from minus infinity to plus infinity, the *X* point moving on a half line from zero to infinity at a speed proportional to the distance from zero. Furthermore, *L* is zero when *X* is one and their speed is equal at this point. The essence of Napier's discovery is that this constitutes a generalization of the relation between the arithmetic and geometric series; *i.e.,* multiplication and raising to a power of the values of the *X* point correspond to addition and multiplication of the values of the *L* point. In modern terminology,

From the point of view of the user it is better to limit the L and X motion by the requirement that L = 1 at X = 10 in addition to the condition that X = 1 at L = 0. This produces the common logarithms to the base 10.These are sometimes known as Briggsian logarithms: the natural logarithms are known as Naperian logarithms. The calculation of logarithms The treatment above differs from that of Napier in that the word "exactly" is applicable rather than "very neerely."
This obscures the ingenious procedure used for calculating the early logarithms, in which powers of numbers such as 1.00001 were used so that multiplication was minimized and replaced by addition. Thus, $X = (1.00001)^n$, $L = n/10^5$ corresponds approximately to $L = \log_e X$, or the natural logarithm.

To obtain the Briggs or base 10 table, the calculation would be continued until X exceeded 10 and then the L scale adjusted so that at X = 10, L = 1.In addition to the discrete series procedure, Napier and Briggs suggested the calculation of logarithms by extracting roots of 10; *i.e.,* log 10 = 0.5, log $10^{1/4}$ = 0.25. This permits the n computation of the previous paragraph to be shortened, for the Briggs logarithm can be adjusted for by taking L = 0.25 for $X = 10^{1/4}$. Power series were not used in the initial construction of the tables. The power series for log(1 + x) and e^x were only available in the 18th century and rigorously established in the early 19th century.

Logarithm tables Napier died in 1617. Briggs published a table of logarithms to 14 places of numbers from 1 to 20,000 and from 90,000 to 100,000 in 1624. Adriaan Vlacq published a 10-place table for values from 1 to 100,000 in 1628, adding the 70,000 values. Both Briggs and Vlacq engaged in setting up log trigonometric tables. Such early tables were either to $^1/_{100}$ of a degree or to a minute of arc. In the 18th century tables were published for 10-second intervals, which were convenient for seven-place tables.

In general, finer intervals are required for logarithmic functions in which the logarithm is taken of smaller numbers; for example, in the calculation of the functions log sin x and log tan x. The related functions modified by division by x in the argument of the logarithm are easily calculated by series for small values of x.

The availability of logarithms greatly influenced the form of plane and spherical trigonometry. Convenient formulas are ones in which the operations that depend on logarithms are done all at once. The recourse to the tables then consists of only two steps. One is obtaining logarithms, the other obtaining antilogs. The procedures of trigonometry were recast to produce such formulas.

(F.J.M.)from encarta encyclopedia
http://encarta.msn.com/index/conciseindex/1F/01FD4000.htm

Logarithm, mathematical power or exponent to which any particular number, called the base, is raised in order to produce another particular number.

In $10^2 = 100$, the logarithm of 100 to the base 10 is 2, written as $\log_{10} 100 = 2$. Common logarithms use the number 10 as the base. Natural logarithms use the transcendental number *e* as a base. The first tables of logarithms were published independently by Scottish mathematician John Napier in 1614 and Swiss mathematician Justus Byrgius in 1620.

The first table of common logarithms was compiled by the English mathematician Henry Briggs.

The problem in constructing a table of logarithms is to make the intervals between successive entries small enough for usefulness in calculating. Logarithm tables have been replaced by electronic calculators and computers with logarithmic functions. Each logarithm contains a whole number and a decimal fraction, called respectively the characteristic and the mantissa. In the common system of logarithms, the logarithm of the number 7 has the characteristic 0 and the mantissa .84510 and is written 0.84510. The logarithm of the number 70 is 1.84510, and the logarithm of the number 700 is 2.84510. The logarithm of the number .7 is -0.15490.

Timeline of Logarithms

by Anthony Fogleman

1550	John Napier1 was born in Edinburgh Scotland.
1552	Jobst Bürgi was born in Switzerland.
1588	Bürgi began working on his logarithms2 independent of Napier (I was unable to find the base to which Bürgi created his logarithms).

~1594	John Napier started work on his tables and spent the next twenty years completing. The tables were for trigonometric applications and gave the logarithms for the sine of angles 30o to 90o. Although Napier did not actually use in his logarithms it could be said his base was roughly 1/e.
1614	Napier published “Mirifici logarithmorum canonis descriptio” in which he discusses his logarithms.
10 March 1615	Henry Briggs wrote a letter roughly translating questions Napier’s use of his base (1/e) and why he did not use base 10 and log 1 = 0. Napier replied that he too had the idea but could not create the tables due to an illness.
Summer 1615	Henry Briggs visited John Napier and they spent a month working on the tables for the logarithms to base 10.
1616	Henry Briggs visited John Napier a second time.
4 April 1617	John Napier passed away.
1617	Briggs published his “Logarithmorum Chilias Prima” which contained his tables for logarithms to base 10.
1619	“Mirifici logarithmorum canonis constructio” is published in which the method

	Napier used for constructing his logarithms is discussed.
1620	Bürgis' were published in his "Arithmetische und Geometrische Progress-Tabulen." Bürgi's work went unnoticed due to the beginning of the Thirty Years' War.
1622	William Oughtred invented the slide rule, which offered an even quicker way of calculating logarithms.
1632	Jobst Bürgi passed away.
1675	Newton discovers the fact that the d/dx ln x = 1/x.
1685	John Wallis realized that logarithms could be defined as exponents.
1694	Johann Bernoulli also realized that logarithms could be defined as exponents.
1694 to present	Logarithms had reached their full potential and most of what was done after 1694 was calculating logarithms to different bases.

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Footnotes & References

1 reworked from the encyclopedia brittanica

2 Napier is also written as Neper and numerous other forms