Names of large numbers

This article lists and discusses the usage and derivation of **names of large numbers**, together with their possible extensions.

The following table lists those names of large numbers which are found in many English dictionaries and thus have a special claim to being "real words". The "Traditional British" values shown are unused in American English and are becoming rare in British English, but their other language variants are dominant in many non-English-speaking areas, including continental Europe and Spanish-speaking countries in Latin America; see Long and short scales.

English also has many words, such as "zillion", used informally to mean large but unspecified amounts; see indefinite and fictitious numbers.

Standard dictionary numbers

Name	Short scale (U.S., Canada and modern British)	Long scale (continental Europe, older British)	Authorities								
			AHD4[1]	CED[2]	COD[3]	OED2[4]	OEDnew[5]	RHD2[6]	SOED3[7]	W3[8]	UM
Million	10^{6}	10^{6}	▯	▯	▯	▯	▯	▯	▯	▯	▯
Milliard		10^{9}	▯	▯		▯	▯	▯			▯
Billion	10^{9}	10^{12}	▯	▯	▯	▯	▯	▯	▯	▯	▯
Trillion	10^{12}	10^{18}	▯	▯	▯	▯	▯	▯	▯	▯	▯
Quadrillion	10^{15}	10^{24}	▯	▯		▯	▯	▯	▯	▯	▯
Quintillion	10^{18}	10^{30}	▯	▯		▯	▯	▯	▯	▯	▯
Sextillion	10^{21}	10^{36}	▯	▯		▯	▯	▯	▯	▯	▯
Septillion	10^{24}	10^{42}	▯	▯		▯	▯	▯	▯	▯	▯
Octillion	10^{27}	10^{48}	▯	▯		▯	▯	▯	▯	▯	▯
Nonillion	10^{30}	10^{54}	▯	▯		▯	▯	▯	▯	▯	▯
Decillion	10^{33}	10^{60}	▯	▯		▯	▯	▯	▯	▯	▯
Undecillion	10^{36}	10^{66}	▯	▯				▯		▯	▯
Duodecillion	10^{39}	10^{72}	▯	▯				▯		▯	▯
Tredecillion	10^{42}	10^{78}	▯	▯				▯		▯	▯
Quattuordecillion	10^{45}	10^{84}	▯					▯		▯	▯
Quindecillion (Quinquadecillion)	10^{48}	10^{90}	▯	▯				▯		▯	▯
Sexdecillion (Sedecillion)	10^{51}	10^{96}	▯	▯				▯		▯	▯
Septendecillion	10^{54}	10^{102}	▯	▯				▯		▯	▯

Octodecillion	10^{57}	10^{108}	☐	☐				☐		☐	☐
Novemdecillion (Novendecillion)	10^{60}	10^{114}	☐	☐				☐		☐	☐
Vigintillion	10^{63}	10^{120}	☐	☐		☐	☐	☐	☐	☐	☐
Centillion	10^{303}	10^{600}	☐	☐		☐	☐	☐			☐

Apart from *million*, the words in this list ending with *-illion* are all derived by adding prefixes (*bi-*, *tri-*, etc., derived from Latin) to the stem *-illion*.[9] *Centillion*[10] appears to be the highest name ending in -"illion" that is included in these dictionaries. *Trigintillion*, often cited as a word in discussions of names of large numbers, is not included in any of them, nor are any of the names that can easily be created by extending the naming pattern (*unvigintillion*, *duovigintillion*, *duoquinquagintillion*, etc.).

Name	Value	Authorities								
		AHD4	CED	COD	OED2	OEDnew	RHD2	SOED3	W3	UM
Googol	10^{100}	☐	☐		☐	☐	☐	☐	☐	☐
Googolplex	10^{Googol}	☐	☐	☐	☐	☐	☐	☐	☐	☐

All of the dictionaries included *googol* and *googolplex*, generally crediting it to the Kasner and Newman book and to Kasner's nephew. None include any higher names in the googol family (googolduplex, etc.). The *Oxford English Dictionary* comments that *googol* and *googolplex* are "not in formal mathematical use".

Usage of names of large numbers

Some names of large numbers, such as *million*, *billion*, and *trillion*, have real referents in human experience, and are encountered in many contexts. At times, the names of large numbers have been forced into common usage as a result of hyperinflation. The highest numerical value banknote ever printed was a note for 1 sextillion pengő (10^{21} or 1 milliard bilpengő as printed) printed in Hungary in 1946. In 2009, Zimbabwe printed a 100 trillion (10^{14}) Zimbabwean dollar note, which at the time of printing was only worth about US$30.

Names of larger numbers, however, have a tenuous, artificial existence, rarely found outside definitions, lists, and discussions of the ways in which large numbers are named. Even well-established names like *sextillion* are rarely used, since in the contexts of science, astronomy, and engineering, where such large numbers often occur, they are nearly always written using scientific notation. In this notation, powers of ten are expressed as *10* with a numeric superscript, e.g., "The X-ray emission of the radio galaxy is 1.3×10^{45} ergs." When a number such as 10^{45} needs to be referred to in words, it is simply read out: "ten to the forty-fifth". This is just as easy to say, easier to understand, and less ambiguous than "quattuordecillion", which means something different in the long scale and the short scale.

When a number represents a quantity rather than a count, SI prefixes can be used—thus "femtosecond", not "one quadrillionth of a second"—although often powers of ten are used instead of some of the very high and very low prefixes. In some cases, specialized units are used, such as the astronomer's parsec and light year or the particle physicist's barn.

Nevertheless, large numbers have an intellectual fascination and are of mathematical interest, and giving them names is one of the ways in which people try to conceptualize and understand them.

One of the first examples of this is *The Sand Reckoner*, in which Archimedes gave a system for naming large numbers. To do this, he called the numbers up to a myriad myriad (10^8) "first numbers" and called 10^8 itself the "unit of the second numbers". Multiples of this unit then became the second numbers, up to this unit taken a myriad myriad times, $10^8 \cdot 10^8 = 10^{16}$. This became the "unit of the third numbers", whose multiples were the third numbers,

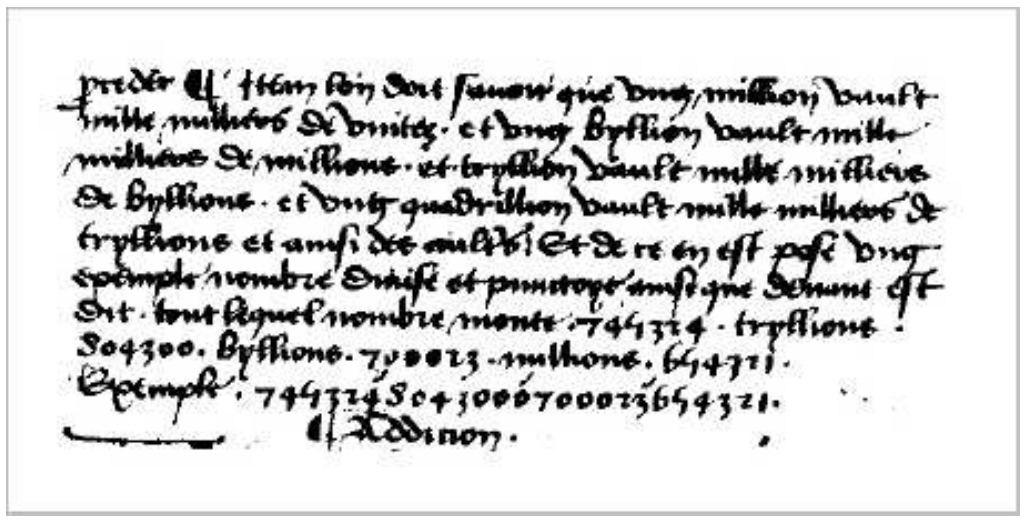
and so on. Archimedes continued naming numbers in this way up to a myriad myriad times the unit of the 10^8-th numbers, i.e., $(10^8)^{(10^8)} = 10^{8 \cdot 10^8}$, and embedded this construction within another copy of itself to produce names for numb

Archimedes then estimated the number of grains of sand that would be required to fill the known Universe, and found that it was no more than "one thousand myriad of the eighth numbers" (10^{63}).

Since then, many others have engaged in the pursuit of conceptualizing and naming numbers that really have no existence outside of the imagination. One motivation for such a pursuit is that attributed to the inventor of the word *googol*, who was certain that any finite number "had to have a name". Another possible motivation is competition between students in computer programming courses, where a common exercise is that of writing a program to output numbers in the form of English words.

Most names proposed for large numbers belong to systematic schemes which are extensible. Thus, many names for large numbers are simply the result of following a naming system to its logical conclusion—or extending it further.

Origins of the "standard dictionary numbers"



The words *bymillion* and *trimillion* were first recorded in 1475 in a manuscript of Jehan Adam. Subsequently, Nicolas Chuquet wrote a book *Triparty en la science des nombres* which was not published during Chuquet's lifetime. However, most of it was copied by Estienne de La Roche for a portion of his 1520 book, *L'arismetique*. Chuquet's book contains a passage in which he shows a large number marked off into groups of six digits, with the comment:

> Ou qui veult le premier point peult signiffier million Le second point byllion Le tiers point tryllion Le quart quadrillion Le cinq^{e} quyllion Le six^{e} sixlion Le sept.^{e} septyllion Le huyt^{e} ottyllion Le neuf^{e} nonyllion et ainsi des ault'^{s} se plus oultre on vouloit preceder
>
> (Or if you prefer the first mark can signify million, the second mark byllion, the third mark tryllion, the fourth quadrillion, the fifth quyillion, the sixth sixlion, the seventh septyllion, the eighth ottyllion, the ninth nonyllion and so on with others as far as you wish to go).

Chuquet is sometimes credited with inventing the names *million*, *billion*, *trillion*, *quadrillion*, and so forth. This is an oversimplification.

Million was certainly not invented by Adam or Chuquet. *Milion* is an Old French word thought to derive from Italian *milione*, an intensification of *mille*, a thousand. That is, a *million* is a *big thousand*.

From the way in which Adam and Chuquet use the words, it can be inferred that they were recording usage rather than inventing it. One obvious possibility is that words similar to *billion* and *trillion* were already in use and well-known, but that Chuquet, an expert in exponentiation, extended the naming scheme and invented the names for the higher powers.

Chuquet's names are only similar to, not identical to, the modern ones.

Adam and Chuquet used the long scale of powers of a million; that is, Adam's *bymillion* (Chuquet's *byllion*) denoted 10^{12}, and Adam's *trimillion* (Chuquet's *tryllion*) denoted 10^{18}.

An *aide-memoire*

It can be a problem to find the values for large numbers, either in scientific notation or in sheer digits. Every number listed in this article larger than a million has two values: one in the short scale, where successive names differ by a factor of one thousand, and another in the long scale, where successive names differ by a factor of one million.

An easy way to find the value of the above numbers in the short scale (as well as the number of zeroes needed to write them) is to take the number indicated by the prefix (such as 2 in *bi*llion, 4 in *quadri*llion, 18 in *octodec*illion, etc.), add one to it, and multiply that result by 3. For example, in a trillion, the prefix is *tri*, meaning 3. Adding 1 to it gives 4. Now multiplying 4 by 3 gives us 12, which is the power to which 10 is to be raised to express a short-scale trillion in scientific notation: one trillion = 10^{12}.

In the long scale, this is done simply by multiplying the number from the prefix by 6. For example, in a billion, the prefix is *bi*, meaning 2. Multiplying 2 by 6 gives us 12, which is the power to which 10 is to be raised to express a long-scale billion in scientific notation: one billion = 10^{12}. The intermediate values (billiard, trilliard, etc.) can be converted in a similar fashion, by adding ½ to the number from the prefix and then multiplying by six. For example, in a septilliard, the prefix is *sept*, meaning 7. Multiplying 7½ by 6 yields 45, and one septilliard equals 10^{45}. Doubling the prefix and adding one then multiplying the result by three would give the same result.

These mechanisms are illustrated in the table in the article on long and short scales.

Note that when writing out large numbers using this system, one should place a comma or space after every three digits, starting from the right and moving left.

The googol family

The names *googol* and *googolplex* were invented by Edward Kasner's nephew, Milton Sirotta, and introduced in Kasner and Newman's 1940 book, *Mathematics and the Imagination*,[11] in the following passage:

> The name "googol" was invented by a child (Dr. Kasner's nine-year-old nephew) who was asked to think up a name for a very big number, namely 1 with one hundred zeroes after it. He was very certain that this number was not infinite, and therefore equally certain that it had to have a name. At the same time that he suggested "googol" he gave a name for a still larger number: "Googolplex". A googolplex is much larger than a googol, but is still finite, as the inventor of the name was quick to point out. It was first suggested that a googolplex should be 1, followed by writing zeros until you got tired. This is a description of what would actually happen if one actually tried to write a googolplex, but different people get tired at different times and it would never do to have Carnera a better mathematician than Dr. Einstein, simply because he had more endurance. The googolplex is, then, a specific finite number, equal to 1 with a googol zeros after it.

Value	Name	Authority
10^{100}	Googol	Kasner and Newman, dictionaries (see above)
$10^{\text{googol}} = 10^{10^{100}}$	Googolplex	Kasner and Newman, dictionaries (see above)

Conway and Guy[12] have suggested that *N-plex* be used as a name for 10^{N}. This gives rise to the name *googolplexplex* for $10^{\text{googolplex}}$. This number (ten to the power of a googolplex) is also known as a googolduplex and googolplexian.[13] Conway and Guy have proposed that *N-minex* be used as a name for 10^{-N}, giving rise to the name *googolminex* for the reciprocal of a googolplex. None of these names are in wide use, nor are any currently found in dictionaries.

Extensions of the standard dictionary numbers

This table illustrates several systems for naming large numbers, and shows how they can be extended past *vigintillion.*

Traditional British usage assigned new names for each power of one million (the long scale): 1,000,000 = 1 million; $1{,}000{,}000^2$ = 1 billion; $1{,}000{,}000^3$ = 1 trillion; and so on. It was adapted from French usage, and is similar to the system that was documented or invented by Chuquet.

Traditional American usage (which, oddly enough, was also adapted from French usage but at a later date), Canadian and modern British usage, assigns new names for each power of one thousand (the short scale.) Thus, a *billion* is $1000 \times 1000^2 = 10^9$; a *trillion* is $1000 \times 1000^3 = 10^{12}$; and so forth. Due to its dominance in the financial world (and by the US dollar), this was adopted for official United Nations documents.

Traditional French usage has varied; in 1948, France, which had been using the short scale, reverted to the long scale.

The term *milliard* is unambiguous and always means 10^9. It is almost never seen in American usage, rarely in British usage, and frequently in European usage. The term is sometimes attributed to French mathematician Jacques Peletier du Mans circa 1550 (for this reason, the long scale is also known as the *Chuquet-Peletier* system), but the Oxford English Dictionary states that the term derives from post-Classical Latin term *milliartum*, which became *milliare* and then *milliart* and finally our modern term.

With regard to names ending in -illiard for numbers 10^{6n+3}, *milliard* is certainly in widespread use in languages other than English, but the degree of actual use of the larger terms is questionable. The terms "Milliarde" in German, "miljard" in Dutch, "milyar" in Turkish and "миллиард" in Russian are standard usage when discussing financial topics.

The naming procedure for large numbers is based on taking the number n occurring in 10^{3n+3} (short scale) or 10^{6n} (long scale) and concatenating Latin roots for its units, tens, and hundreds place, together with the suffix *-illion*. In this way, numbers up to $10^{3 \cdot 999+3} = 10^{3000}$ (short scale) or $10^{6 \cdot 999} = 10^{5994}$ (long scale) may be named. The choice of roots and the concatenation procedure is that of the standard dictionary numbers if n is 20 or smaller, and, for larger n (between 21 and 999), is due to John Horton Conway and Richard K. Guy:

	Units	**Tens**	**Hundreds**
1	Un	^{N}Deci	^{NX}Centi
2	Duo	^{MS}Viginti	^{N}Ducenti
3	Tre $^{(*)}$	^{NS}Triginta	^{NS}Trecenti
4	Quattuor	^{NS}Quadraginta	^{NS}Quadringenti
5	Quinqua	^{NS}Quinquaginta	^{NS}Quingenti
6	Se $^{(*)}$	^{N}Sexaginta	^{N}Sescenti
7	Septe $^{(*)}$	^{N}Septuaginta	^{N}Septingenti
8	Octo	^{MX}Octoginta	^{MX}Octingenti
9	Nove $^{(*)}$	Nonaginta	Nongenti

$^{(*)}$ ^ When preceding a component marked ^{S} or ^{X}, “tre” increases to “tres” and “se” to “ses” or “sex”; similarly, when preceding a component marked ^{M} or ^{N}, “septe” and “nove” increase to “septem” and “novem” or “septen” and “noven”.

Since the system of using Latin prefixes will become ambiguous for numbers with exponents of a size which the Romans rarely counted to, like $10^{6,000,258}$, Conway and Guy have also proposed a consistent set of conventions which permit, in principle, the extension of this system to provide English names for any integer whatsoever.

Names of reciprocals of large numbers do not need to be listed here, because they are regularly formed by adding -th, e.g. *quattuordecillionth, centillionth,* etc.

For additional details, see billion and long and short scales.

Base -illion (short scale)	Value	U.S., Canada and modern British (short scale)	Traditional British (long scale)	Traditional European (Peletier) (long scale)	SI Symbol	SI Prefix
1	10^6	Million	Million	Million	M	Mega-
2	10^9	Billion	Thousand million	Milliard	G	Giga-
3	10^{12}	Trillion	Billion	Billion	T	Tera-
4	10^{15}	Quadrillion	Thousand billion	Billiard	P	Peta-
5	10^{18}	Quintillion	Trillion	Trillion	E	Exa-
6	10^{21}	Sextillion	Thousand trillion	Trilliard	Z	Zetta-
7	10^{24}	Septillion	Quadrillion	Quadrillion	Y	Yotta-
8	10^{27}	Octillion	Thousand quadrillion	Quadrilliard		
9	10^{30}	Nonillion	Quintillion	Quintillion		
10	10^{33}	Decillion	Thousand quintillion	Quintilliard		
11	10^{36}	Undecillion	Sextillion	Sextillion		
12	10^{39}	Duodecillion	Thousand sextillion	Sextilliard		
13	10^{42}	Tredecillion	Septillion	Septillion		
14	10^{45}	Quattuordecillion	Thousand septillion	Septilliard		
15	10^{48}	Quinquadecillion	Octillion	Octillion		
16	10^{51}	Sedecillion	Thousand octillion	Octilliard		
17	10^{54}	Septendecillion	Nonillion	Nonillion		
18	10^{57}	Octodecillion	Thousand nonillion	Nonilliard		
19	10^{60}	Novendecillion	Decillion	Decillion		
20	10^{63}	Vigintillion	Thousand decillion	Decilliard		
21	10^{66}	Unvigintillion	Undecillion	Undecillion		
22	10^{69}	Duovigintillion	Thousand undecillion	Undecilliard		
23	10^{72}	Tresvigintillion	Duodecillion	Duodecillion		
24	10^{75}	Quattuorvigintillion	Thousand duodecillion	Duodecilliard		
25	10^{78}	Quinquavigintillion	Tredecillion	Tredecillion		

26	10^{81}	Sesvigintillion	Thousand tredecillion	Tredecilliard		
27	10^{84}	Septemvigintillion	Quattuordecillion	Quattuordecillion		
28	10^{87}	Octovigintillion	Thousand quattuordecillion	Quattuordecilliard		
29	10^{90}	Novemvigintillion	Quindecillion	Quindecillion		
30	10^{93}	Trigintillion	Thousand quindecillion	Quindecilliard		
31	10^{96}	Untrigintillion	Sedecillion	Sedecillion		
32	10^{99}	Duotrigintillion	Thousand sedecillion	Sedecilliard		
33	10^{102}	Trestrigintillion	Septendecillion	Septendecillion		
34	10^{105}	Quattuortrigintillion	Thousand septendecillion	Septendecilliard		
35	10^{108}	Quinquatrigintillion	Octodecillion	Octodecillion		
36	10^{111}	Sestrigintillion	Thousand octodecillion	Octodecilliard		
37	10^{114}	Septentrigintillion	Novendecillion	Novendecillion		
38	10^{117}	Octotrigintillion	Thousand novendecillion	Novendecilliard		
39	10^{120}	Noventrigintillion	Vigintillion	Vigintillion		
40	10^{123}	Quadragintillion	Thousand vigintillion	Vigintilliard		
50	10^{153}	Quinquagintillion	Thousand quinquavigintillion	Quinquavigintilliard		
60	10^{183}	Sexagintillion	Thousand trigintillion	Trigintilliard		
70	10^{213}	Septuagintillion	Thousand quinquatrigintillion	Quinquatrigintilliard		
80	10^{243}	Octogintillion	Thousand quadragintillion	Quadragintilliard		
90	10^{273}	Nonagintillion	Thousand quinquaquadragintillion	Quinquaquadragintilliard		
100	10^{303}	Centillion	Thousand quinquagintillion	Quinquagintilliard		
101	10^{306}	Uncentillion	Unquinquagintillion	Unquinquagintillion		
102	10^{309}	Duocentillion	Thousand unquinquagintillion	Unquinquagintilliard		
103	10^{312}	Trescentillion	Duoquinquagintillion	Duoquinquagintillion		
110	10^{333}	Decicentillion	Thousand quinquaquinquagintillion	Quinquaquinquagintilliard		
111	10^{336}	Undecicentillion	Sesquinquagintillion	Sesquinquagintillion		
120	10^{363}	Viginticentillion	Thousand sexagintillion	Sexagintilliard		
121	10^{366}	Unviginticentillion	Unsexagintillion	Unsexagintillion		
130	10^{393}	Trigintacentillion	Thousand quinquasexagintillion	Quinquasexagintilliard		
140	10^{423}	Quadragintacentillion	Thousand septuagintillion	Septuagintilliard		
150	10^{453}	Quinquagintacentillion	Thousand quinquaseptuagintillion	Quinquaseptuagintilliard		
160	10^{483}	Sexagintacentillion	Thousand octogintillion	Octogintilliard		

170	10^{513}	Septuagintacentillion	Thousand quinquaoctogintillion	Quinquaoctogintilliard		
180	10^{543}	Octogintacentillion	Thousand nonagintillion	Nonagintilliard		
190	10^{573}	Nonagintacentillion	Thousand quinquanonagintillion	Quinquanonagintilliard		
200	10^{603}	Ducentillion	Thousand centillion	Centilliard		
300	10^{903}	Trecentillion	Thousand quinquagintacentillion	Quinquagintacentilliard		
400	10^{1203}	Quadringentillion	Thousand ducentillion	Ducentilliard		
500	10^{1503}	Quingentillion	Thousand quinquagintaducentillion	Quinquagintaducentilliard		
600	10^{1803}	Sescentillion	Thousand trecentillion	Trecentilliard		
700	10^{2103}	Septingentillion	Thousand quinquagintatrecentillion	Quinquagintatrecentilliard		
800	10^{2403}	Octingentillion	Thousand quadringentillion	Quadringentilliard		
900	10^{2703}	Nongentillion	Thousand quinquagintaquadringentillion	Quinquagintaquadringentilliard		
1000	10^{3003}	Millinillion	Thousand quingentillion	Quingentilliard		

Value	U.S., Canada and modern British (short scale)	Traditional British (long scale)	Traditional European (Peletier) (long scale)
10^{100}	Googol (Ten duotrigintillion)	Googol (Ten thousand sedecillion)	Googol (Ten sedecilliard)
$10^{10^{100}}$	Googolplex	Googolplex	Googolplex

Binary prefixes

The International System of Quantities (ISQ) defines a series of prefixes denoting integer powers of 1024 between 1024^1 and 1024^8.

Power	Value	ISQ Symbol	ISQ Prefix
1	1024^1	Ki	Kibi-
2	1024^2	Mi	Mebi-
3	1024^3	Gi	Gibi-
4	1024^4	Ti	Tebi-
5	1024^5	Pi	Pebi-
6	1024^6	Ei	Exbi-
7	1024^7	Zi	Zebi-
8	1024^8	Yi	Yobi-

Proposals for new naming system

See also: -yllion

In 2001, Russ Rowlett, Director of the Center for Mathematics and Science Education at the University of North Carolina at Chapel Hill proposed that, to avoid confusion, the Latin-based short scale and long scale systems should be replaced by an unambiguous Greek-based system for naming large numbers that would be based on powers of one thousand.

Value	Name
10^{3}	Thousand
10^{6}	Million
10^{9}	Gillion
10^{12}	Tetrillion
10^{15}	Pentillion
10^{18}	Hexillion
10^{21}	Heptillion
10^{24}	Oktillion
10^{27}	Ennillion
10^{30}	Dekillion

Value	Name
10^{33}	Hendekillion
10^{36}	Dodekillion
10^{39}	Trisdekillion
10^{42}	Tetradekillion
10^{45}	Pentadekillion
10^{48}	Hexadekillion
10^{51}	Heptadekillion
10^{54}	Oktadekillion
10^{57}	Enneadekillion
10^{60}	Icosillion

Value	Name
10^{63}	Icosihenillion
10^{66}	Icosidillion
10^{69}	Icositrillion
10^{72}	Icositetrillion
10^{75}	Icosipentillion
10^{78}	Icosihexillion
10^{81}	Icosiheptillion
10^{84}	Icosioktillion
10^{87}	Icosiennillion
10^{90}	Triacontillion

Other large numbers used in mathematics and physics

- Avogadro's number
- Graham's number
- Skewes' number
- Steinhaus–Moser notation

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[10] Entry for *centillion* in the *American Heritage Dictionary* (http://dictionary.reference.com/search?q=centillion)

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External links

- Robert Munafo's Large Numbers (http://www.mrob.com/pub/math/largenum.html)
- *How high can you count?* (http://www.isthe.com/chongo/tech/math/number/howhigh.html) by Landon Curt Noll.
- Full list of large number names (http://home.kpn.nl/vanadovv/BignumbyN.html) list sorted by 10^n and by word length
- Big numbers (http://www.mathcats.com/explore/reallybignumbers.html) Educational site, which can name any numbers put into it (up to centillion)
- The English name of a number (http://www.isthe.com/cgi-bin/chongo/number.cgi) An online tool that prints names of numbers of any size

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