

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 that are found in many English dictionaries and thus have a claim to being "real words." The "Traditional British" values shown are unused in American English and are obsolete 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.

Indian English does not use millions, but has its own system of large numbers including lakhs and crores. English also has many words, such as "zillion", used informally to mean large but unspecified amounts; see indefinite and fictitious numbers.

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References

Standard dictionary numbers

Name	Short scale (US, Eastern Europe, English Canadian, Australian, and modern British)	Long scale (Western, Central Europe, older British, and French Canadian)	Authorities								
			AHD4 ^[1]	CED ^[2]	COD ^[3]	OED2 ^[4]	OEDnew ^[5]	RHD2 ^[6]	SOED3 ^[7]	W3 ^[8]	UM ^[9]
Million	10 ⁶	10 ⁶	✓	✓	✓	✓	✓	✓	✓	✓	✓
Milliard		10 ⁹	✓	✓		✓	✓	✓			✓
Billion	10 ⁹	10 ¹²	✓	✓	✓	✓	✓	✓	✓	✓	✓
Billiard		10 ¹⁵	✓	✓		✓	✓	✓			✓
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	10 ⁴⁸	10 ⁹⁰	✓	✓				✓		✓	✓
Sexdecillion	10 ⁵¹	10 ⁹⁶	✓	✓				✓		✓	✓
Septendecillion	10 ⁵⁴	10 ¹⁰²	✓	✓				✓		✓	✓
Octodecillion	10 ⁵⁷	10 ¹⁰⁸	✓	✓				✓		✓	✓
Novemdecillion	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*.^[10] *Centillion*^[11] 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
<u>Googol</u>	10 ¹⁰⁰	✓	✓	✓	✓	✓	✓	✓	✓	✓
<u>Googolplex</u>	10 ^{googol} (10 ^{10¹⁰⁰})	✓	✓	✓	✓	✓	✓	✓	✓	✓

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 (10²¹ or 1 milliard bilpengő as printed) printed in Hungary in 1946. In 2009, Zimbabwe printed a 100 trillion (10¹⁴) Zimbabwean dollar note, which at the time of printing was worth about US\$30.^[12]

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 context of science, including astronomy, 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 × 10⁴⁵ joules." When a number such as 10⁴⁵ needs to be referred to in words, it is simply read out as "ten to the forty-fifth". This is easier to say 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 earliest 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 (10⁸) "first numbers" and called 10⁸ 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, 10⁸·10⁸=10¹⁶. 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 10⁸-th numbers, i.e. (10⁸)^(10⁸) = 10^{8·10⁸}, and embedded this construction within another copy of itself to produce names for numbers up to ((10⁸)^(10⁸))^(10⁸) = 10^{8·10¹⁶}. 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" (10⁶³).

Since then, many others have engaged in the pursuit of conceptualizing and naming numbers that really have no existence outside 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
otyllion Le neuf^e nonyllion et ainsi des
ault^s se plus outre 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).

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} .

The googol family

The names *googol* and *googolplex* were invented by Edward Kasner's nephew Milton Sirota and introduced in Kasner and Newman's 1940 book *Mathematics and the Imagination*^[13] 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}	<u>Googol</u>	Kasner and Newman, dictionaries (see above)
$10^{\text{googol}} = 10^{10^{100}}$	<u>Googolplex</u>	Kasner and Newman, dictionaries (see above)

Conway and Guy^[14] have suggested that *N-plex* be used as a name for 10^N . This gives rise to the name *googolplexplex* for $10^{\text{googolplex}} = 10^{10^{100}}$. This number (ten to the power of a googolplex) is also known as a googolduplex and googolplexian.^[15] Conway and Guy^[14] 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.

The names *googol* and *googolplex* inspired the name of the Internet company Google and its corporate headquarters, the Googleplex, respectively.

Extensions of the standard dictionary numbers

This section 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 was also adapted from French usage but at a later date), Canadian, and modern British usage assign 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 and rarely in British usage, but frequently in continental 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.

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

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 9 or smaller. For larger n (between 10 and 999), prefixes can be constructed based on a system described by John Horton Conway and Richard K. Guy.^[14] Today sexdecillion and novemdecillion are standard dictionary numbers and, using the same reasoning as Conway and Guy did for the numbers up to nonillion, could probably be used to form acceptable prefixes. The Conway-Guy system for forming prefixes:

	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” changes to “tres” and “se” to “ses” or “sex”; similarly, when preceding a component marked ^M or ^N, “septe” and “nove” change 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.^[14]

The following table shows number names generated by the system described by Conway and Guy for the short and long scales.

Names of reciprocals of large numbers are not listed, as they are regularly formed by adding -th, e.g. *quattuordecillionth*, *centillionth*, etc.

Base - illion (short scale)	Base - illion (long scale)	Value	US, Canada and modern British (short scale)	Traditional British (long scale)	Traditional European (Peletier) (long scale)	SI Symbol	SI Prefix
1	1	10 ⁶	Million	Million	Million	M	<u>Mega-</u>
2	1	10 ⁹	Billion	Thousand million	Milliard	G	<u>Giga-</u>
3	2	10 ¹²	Trillion	Billion	Billion	T	<u>Tera-</u>
4	2	10 ¹⁵	Quadrillion	Thousand billion	Billiard	P	<u>Peta-</u>
5	3	10 ¹⁸	Quintillion	Trillion	Trillion	E	<u>Exa-</u>
6	3	10 ²¹	Sextillion	Thousand trillion	Trilliard	Z	<u>Zetta-</u>
7	4	10 ²⁴	Septillion	Quadrillion	Quadrillion	Y	<u>Yotta-</u>
8	4	10 ²⁷	Octillion	Thousand quadrillion	Quadrilliard		
9	5	10 ³⁰	Nonillion	Quintillion	Quintillion		
10	5	10 ³³	Decillion	Thousand quintillion	Quintilliard		
11	6	10 ³⁶	Undecillion	Sextillion	Sextillion		
12	6	10 ³⁹	Duodecillion	Thousand sextillion	Sextilliard		
13	7	10 ⁴²	Tredecillion	Septillion	Septillion		
14	7	10 ⁴⁵	Quattuordecillion	Thousand septillion	Septilliard		
15	8	10 ⁴⁸	Quindecillion	Octillion	Octillion		
16	8	10 ⁵¹	Sedecillion	Thousand octillion	Octilliard		
17	9	10 ⁵⁴	Septendecillion	Nonillion	Nonillion		
18	9	10 ⁵⁷	Octodecillion	Thousand nonillion	Nonilliard		
19	10	10 ⁶⁰	Novendecillion	Decillion	Decillion		
20	10	10 ⁶³	Vigintillion	Thousand decillion	Decilliard		
21	11	10 ⁶⁶	Unvigintillion	Undecillion	Undecillion		
22	11	10 ⁶⁹	Duovigintillion	Thousand undecillion	Undecilliard		
23	12	10 ⁷²	Tresvigintillion	Duodecillion	Duodecillion		
24	12	10 ⁷⁵	Quattuorvigintillion	Thousand duodecillion	Duodecilliard		
25	13	10 ⁷⁸	Quinvigintillion	Tredecillion	Tredecillion		
26	13	10 ⁸¹	Sesvigintillion	Thousand tredecillion	Tredecilliard		
27	14	10 ⁸⁴	Septemvigintillion	Quattuordecillion	Quattuordecillion		
28	14	10 ⁸⁷	Octovigintillion	Thousand quattuordecillion	Quattuordecilliard		
29	15	10 ⁹⁰	Novemvigintillion	Quindecillion	Quindecillion		
30	15	10 ⁹³	Trigintillion	Thousand quindecillion	Quindecilliard		
31	16	10 ⁹⁶	Untrigintillion	Sedecillion	Sedecillion		
32	16	10 ⁹⁹	Duotrigintillion	Thousand sedecillion	Sedecilliard		
33	17	10 ¹⁰²	Trestrigintillion	Septendecillion	Septendecillion		
34	17	10 ¹⁰⁵	Quattuortrigintillion	Thousand septendecillion	Septendecilliard		
35	18	10 ¹⁰⁸	Quintrigintillion	Octodecillion	Octodecillion		
36	18	10 ¹¹¹	Sestrigintillion	Thousand octodecillion	Octodecilliard		
37	19	10 ¹¹⁴	Septentrigintillion	Novendecillion	Novendecillion		
38	19	10 ¹¹⁷	Octotrigintillion	Thousand novendecillion	Novendecilliard		
39	20	10 ¹²⁰	Noventrigintillion	Vigintillion	Vigintillion		
40	20	10 ¹²³	Quadragintillion	Thousand vigintillion	Vigintilliard		
50	25	10 ¹⁵³	Quinquagintillion	Thousand quinvigintillion	Quinvigintilliard		

60	30	10 ¹⁸³	Sexagintillion	Thousand triginillion	Trigintilliard
70	35	10 ²¹³	Septuagintillion	Thousand quintriginillion	Quintriginilliard
80	40	10 ²⁴³	Octogintillion	Thousand quadragintillion	Quadragintilliard
90	45	10 ²⁷³	Nonagintillion	Thousand quinquagintillion	Quinquagintilliard
100	50	10 ³⁰³	Centillion	Thousand quinquagintillion	Quinquagintilliard
101	51	10 ³⁰⁶	Uncentillion	Unquinquagintillion	Unquinquagintillion
110	55	10 ³³³	Decicentillion	Thousand quinquinquagintillion	Quinquinquagintilliard
111	56	10 ³³⁶	Undecicentillion	Sesquinquagintillion	Sesquinquagintillion
120	60	10 ³⁶³	Viginticentillion	Thousand sexagintillion	Sexagintilliard
121	61	10 ³⁶⁶	Unviginticentillion	Unsexagintillion	Unsexagintillion
130	65	10 ³⁹³	Trigintacentillion	Thousand quinsexagintillion	Quinsexagintilliard
140	70	10 ⁴²³	Quadragintacentillion	Thousand septuagintillion	Septuagintilliard
150	75	10 ⁴⁵³	Quinquagintacentillion	Thousand quinseptuagintillion	Quinseptuagintilliard
160	80	10 ⁴⁸³	Sexagintacentillion	Thousand octogintillion	Octogintilliard
170	85	10 ⁵¹³	Septuagintacentillion	Thousand quinoctogintillion	Quinoctogintilliard
180	90	10 ⁵⁴³	Octogintacentillion	Thousand nonagintillion	Nonagintilliard
190	95	10 ⁵⁷³	Nonagintacentillion	Thousand quinnonagintillion	Quinnonagintilliard
200	100	10 ⁶⁰³	Ducentillion	Thousand centillion	Centilliard
300	150	10 ⁹⁰³	Trecentillion	Thousand quinquagintacentillion	Quinquagintacentilliard
400	200	10 ¹²⁰³	Quadrilingentillion	Thousand ducentillion	Ducentilliard
500	250	10 ¹⁵⁰³	Quingentillion	Thousand quinquagintaducentillion	Quinquagintaducentilliard
600	300	10 ¹⁸⁰³	Sescentillion	Thousand trecentillion	Trecentilliard
700	350	10 ²¹⁰³	Septingentillion	Thousand quinquagintatrecentillion	Quinquagintatrecentilliard
800	400	10 ²⁴⁰³	Octingentillion	Thousand quadringentillion	Quadringentilliard
900	450	10 ²⁷⁰³	Nongentillion	Thousand quinquagintaquadringentillion	Quinquagintaquadringentilliard
1000	500	10 ³⁰⁰³	Millinillion	Thousand quingentillion	Quingentilliard

Value	Name	Equivalent		
		US, Canadian and modern British (short scale)	Traditional British (long scale)	Traditional European (Peletier) (long scale)
10 ¹⁰⁰	Googol	Ten duotrigintillion	Ten thousand sedecillion	Ten sedecilliard
10 ^{10¹⁰⁰}	Googolplex	n/a	n/a	n/a

Binary prefixes

The International System of Quantities (ISQ) defines a series of prefixes denoting integer powers of 1024 between 1024¹ and 1024⁸.^[16]

Power	Value	ISQ symbol	ISQ prefix
1	1024 ¹	Ki	<u>Kibi-</u>
2	1024 ²	Mi	<u>Mebi-</u>
3	1024 ³	Gi	<u>Gibi-</u>
4	1024 ⁴	Ti	<u>Tebi-</u>
5	1024 ⁵	Pi	<u>Pebi-</u>
6	1024 ⁶	Ei	<u>Exbi-</u>
7	1024 ⁷	Zi	<u>Zebi-</u>
8	1024 ⁸	Yi	<u>Yobi-</u>

Other large numbers used in mathematics and physics

- Avogadro number
- Graham's number
- Skewes' number
- Steinhaus–Moser notation
- TREE(3)

See also

- -yllion
- Asamkhyeya
- Chinese numerals
- History of large numbers
- Indefinite and fictitious numbers
- Indian numbering system
- Knuth's up-arrow notation
- Law of large numbers
- List of numbers
- Long and short scales
- Metric prefix
- Names of small numbers
- Nicolas Chuquet
- Number names
- Number prefix
- Orders of magnitude
- Orders of magnitude (data)
- Orders of magnitude (numbers)
- Powers of 10

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