

BIG NUMBERS

or

How To Say A Bigger Number Than Your Friend

The word *million* entered into English sometime in the fourteenth century, from the Italian *millione* meaning, literally, a great-thousand, derived from the Latin *mille*, one thousand.

The word *billion* followed three hundred years later, and unfortunately means different things in different parts of the world. In the US, a billion is one thousand millions; in Europe a billion is a bi-million, that is, a million millions.

This pattern persists: We continue with Latin prefixes, bi (2), tri (3), quadri (4), quinti (5), sexti (6), septi (7) etc. But again, the words are used differently in the US and in Europe:

In the US, a trillion is a thousand billions, a quadrillion is a thousand trillions, etc. In Europe, a trillion is million billions, a quadrillion is a million trillions, etc.

We can summarize all this in the following chart:

| | US | Europe |
|-------------------|---------------|-------------------|
| million | 1,000,000 | 1,000,000 |
| billion | 1,000,000,000 | 1,000,000,000,000 |
| trillion | 10^{12} | 10^{18} |
| quadrillion | 10^{15} | 10^{24} |
| quintillion | | |
| sextillion | | |
| septillion | | |
| octillion | | |
| nonillion | | |
| decillion | | |
| undecillion | | |
| duodecillion | | |
| tredecillion | | |
| quattuordecillion | | |
| quindecillion | | |
| sexdecillion | | |
| septdecillion | | |
| octodecillion | | |
| novemdecillion | | |
| vigintillion | | |

we'll stick with the US usage here.

So 1,292,277,091,999,000,000,000,000,231,444,000,001 is one duodecillion, two hundred ninety two undecillion, two hundred seventy seven decillion, ninety one nonillion, nine hundred ninety nine octillion, two hundred thirty one trillion, four hundred forty four billion and one.

It is amusing to calculate various amounts (from Wikipedia)
 There are a quadrillion grains of sand on a beach.
 There are a quadrillion ants in the world.
 There are 632 quadrillion seconds in 20 billion years.
 The average distance between galaxies is 15 quintillion miles.
 A quintillion kernels of wheat have been produced on the planet.
 There are a quintillion pounds of the Earth's atmosphere.
 The volume of our galaxy is 1 sexdecillion cubic miles.
 The Earth's weight is 13 septillion in pounds.
 In a glass of water, there are 24 septillion atoms.
 There are 15 octillion inches from one end of the universe to the other.
 The sun weighs 4 nonillion pounds.
 The sun is 86 nonillion cubic inches in volume.
 The area of our galaxy is 273 decillion square miles.
 There are 1 undecillion living things on Earth.
 There are 200 tredecillion atoms in the atmosphere.
 There are 89 quindecillion atoms of the Earth.
 There are 142 quattuordecillion atoms on the surface of the Earth.
 A slice through the center of the universe is 90 quattuordecillion square miles.
 There are 1 octodecillion atoms in the sun.
 There are 1 vigintillion cubic inches in our galaxy.

The great mathematician Archimedes invented a means of expressing truly huge numbers; along the way, he worked out an estimate for the number of grains of sand needed to fill the universe (as he understood it) — approximately one vigintillion! Not bad!

Hindu mathematicians had a fondness for expressing gigantic numbers, partly as a means of approaching the godhead. A rajju is the distance covered by a deva flying for six months at the rate of ten million miles per blink of an eye. A palya is the length of time it takes to build a cube of lambswool ten miles high, if one strand was laid down every century. Lord Adinath came to India 100,000,000,000,000 palyas ago.
 Those with some facility may wish to estimate for themselves how large these numbers really are.

A googol (not google!) is 1 followed by 100 zeros, i.e. 10^{100} .

Conway and Weschler devised a clever system for extending the Latin "illion" names to allow numbers up to three thousand digits long. Remember that just as a (bi)llion has 2 x three, plus three digits (that is, 9) and a (tri)llion has 3 x three, plus three (that is 12), in general an (N)llion will have 3N+3 digits. But how to name the N?

| | 1's | 10's | 100's |
|---|------------|-------------------|------------------|
| 0 | - | - | - |
| 1 | un | (n) deci | (nx) centi |
| 2 | duo | (ms) viginti | (n) ducenti |
| 3 | tre (*) | (ns) triginta | (ns) trecenti |
| 4 | quattuor | (ns) quadraginta | (ns) quadingenti |
| 5 | quin | (ns) quinquaginta | (ns) quingenti |
| 6 | se (sx) | (n) sexaginta | (n) sescenti |
| 7 | septe (mn) | (n) septuaginta | (n) septingenti |
| 8 | octo | (mx) octoginta | (mx) octingenti |
| 9 | nove (mn) | nonaginta | nongenti |

String these together, 1s 10s and 100s; if the same letter appears in parantheses at the end of one segment and the beginning of the next, stick it in, and change any final a to an i. Stick "llion" on the end! So 349 is novenquadragintatrecenti, & a one followed by 3x349+3 digits is a novenquadragintatrecentillion!

But these numbers are still comparatively small. What about a one followed by a million zeros? A one followed by a septillion zeros?

As weird as these numbers seem, they're not really too out of reach. An ordinary computer screen, for example, has about a million pixels, each one of which can show any of about a million colors. The total number of possible images on the screen then is a staggering $\text{million}^{\text{million}} = (10^6)^{(10^6)} = 10^{(6 \cdot 10^6)}$. Lets round up and call that 10^{10^7} .

At least it is not too hard to write these out in exponential notation. A septillion is 10^{24} and so a one followed by a septillion zeros is

$$10^{10^{24}}$$

A googolplex is a truly staggering number:

$$10^{\text{googol}} = 10^{10^{100}}$$

But you know what? This ain't nuthin. We're just getting started.