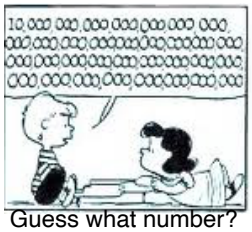
Math Magic: Kids' fascination with large numbers

Issue #14: Naming Large numbers (grades 7-12) An Index of All Math Magic Activities

TWO FIVE-YEAR-OLDS IN A NUMBER DUEL


Guess what number?

Forty years ago I overheard our five-year-old son David ask his friend Lance (as they played in the sandbox) if he knew that the name of the largest number was a **googol**, a one followed by 100 zeroes (10^{100}). Lance, whose father happened to be a rocket scientist, responded that a **googolplex** was the largest named number, a googol with a googol number of zeroes after one (10^{googol}). Yipes, I thought, what had we wrought! At least this precocious duo were not comparing body parts. They are still best of friends.

It's amazing how small kids gravitate toward grandiose concepts or creations such as numbers, dinosaurs, and superheroes. The term googol was coined in 1920 by 9-year-old Milton Sirotta, nephew of US mathematician Edward Kasner who popularized the concept in his 1940's book *Mathematics and the Imagination*. (Note that the computer company Google is a misspelling of googol.) more...

EXTENDING POWERS TO UNDERSTAND

Most 7-8 graders know that 10 x 10 = 10^2 = 100 and is read 10 squared or ten to the second power. (The small 2 is called **the exponent**, and 10 is **the base**.) Likewise, 10 x 10 x 10 = 10^3 = 1000, etc. It just so happens in base 10 the exponent also equals the number of zeroes after the one. However, 10^0, 10^{-1}, 10^{-2}, etc., often confuses people.

To explain I create a chart starting with **10^2 = 10 x 10 = 100** and move up and down from there, noticing the patterns. Study the chart above and notice the progression as it moves up or down from **10^2** Fill in the blanks. (Note: from **10^2** on the chart, going down **increases** by 10 times, going up **decreases** by 10 times.) **General Rules: #1** : any negative exponent is a fraction of the base. **#2**: Any base to the 1st power = the base (10^1 = 10, or 3^1 = 3 or n^1 = n). **#3**: Any base to the 0 power = 1 (10^0 = 1 or 3^0 = 1 or n^0 = 1). This will take practice, and will also review decimals.

10^{-4} = _____ (1/10 ***of*** 1/1000 = 1/10 x 1/1000 = 1/10,000 or .0001)
10^{-3} = _____ (1/10 ***of*** 1/100 = 1/10 x 1/100 = 1/1000 or .001)
10^{-2} = _____ (1/10 ***of*** 1/10 = 1/10 x 1/10 = 1/100 or .01)
10^{-1} = _____ (1/10 ***of*** the 1 below = 1/10 x 1 = 1/10 or .1)
10^0 = _____ (1/10 ***of*** 10 below = 1/10 x 10 = 1)
10^1 = 10 (1/10 ***of*** the 100 below = 1/10 x 100 = 10)
10^2 = 10 x 10 = 100 START HERE WORKING UP AND DOWN
10^3 = 10 x 10 x 10 = 1000 (10 X the 100 above)
10^4 = _____ (10 X the 1000 above)

hundred	10^2	100
thousand	10^3	1,000
million	10^6	1,000,000
billion	10^9	1,000,000,000
trillion	10^{12}	1,000,000,000,000
quadrillion	10^{15}	1,000,000,000,000,000
quintillion	10^{18}	1,000,000,000,000,000,000
sextillion	10^{21}	1 with 21 zeroes
septillion	10^{24}	1 with ___ zeroes
octillion	10^{27}	1 with ___ zeroes
nonillion	10^{30}	1 with ___ zeroes
decillion	10^{33}	1 with ___ zeroes
googol	10^{-----}	1 with ___ zeroes

A LIST OF NAMES AND EXPONENTIAL FORMS OF SOME LARGE NUMBERS

Why do you think the red names above are used most often? _____

billion, mil. thous, units

sex. quint, quad, tril. billion, mil. thous, units

EXAMPLES: finding **word names** or **numerals** from the chart above and using the boxed group names:

567, 395, 000, 000 = 567 billion, 395 million

495, 234, 000, 000, 845, 000, 000, 000 = the word name:

_____

Why might the number below unrealistic? 456 quintillion, 450 thousand, 23 or 450, 000, 000, 000, 000, 450, 023

You some yourself, using the chart to help you:

2 quadrillion = _____

10^{27} = _____

348, 000, 002, 000, 000 = _____

There are approximately 100 billion stars in our Milky Way galaxy. Write this as numeral: _____

For answers to this page. A better way on next page.

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A glass of water has approximately 10, 000,000,000,000, 000,000,000,000 molecules. Write this as a word name:

_____

There are about 7.5 billion people in the world. Write that as a numeral: _____ Think: why would a more exact census number be not accurate?

WHY WE NEED A BETTER WAY TO WRITE REALLY LARGE OR SMALL NUMBERS

Often writing the **word name** or the **numeral** (the number form) for really large or really small numbers does not work well. First, a really large number takes up too much space. (Imagine writing out a google with 1 followed by 100 zeroes.) Second, it's difficult to count the zeroes or figure the number's word name.

SCIENTIFIC NOTATION INVENTED FOR VERY LARGE OR VERY SMALL NUMBERS

(I will try to explain scientific notation in writing, but it is much better explained in the following youtube video.)

In EXAMPLE 1: to express 345 billion = 345, 000, 000, 000 in scientific notation do the following:

FIRST, move the decimal point to put the left most digit in the one's place so you get 3.45. SECOND, note how many places you move over to the left to do this (here it is 11 places). THIRD, multiply that by 10 to the 11th power, the number of places you moved over in the first step.

EX 1: so 345 billion = 345, 000, 000, 000 = **3.45×10^{11}**

EX 2: 4.5×10^{13} **= 45, 000, 000, 000, 000 or 45 trillion**
(Here move the decimal point to the right 13 places and add zero place holders.)

YOU TRY: 97 thousand =_____ = $9.7 \times 10^{\cdots}$
and the reverse: 3.47×10^{6} = _____
(where you move the decimal point over 6 places as in the exponent)

Astronomers have reason to believe that there are about **5.9 trillion miles in a light year**, which is how fast light can travel in a year's time. Write the word name for this numeral; _____ and express this in scientific notation _____

There are about 1×10^{5} brown or black hairs on the human scalp. How many is that?
_____

Blonds average 150, 000, redheads, 90,000. Express as in scientific notation: _____ and _____ ref.

SCIENTIFIC NOTATION FOR SMALL NUMBERS

"**Small numbers** are numbers that are small compared with the numbers used in everyday life. **Very small numbers** often occur in fields such as chemistry, electronics, and quantum physics." For example,

The radius of a hydrogen atom: 2.5×10^{-11} m
(the -11 exponent means move the decimal of 2.5 11 places to the left; making the number smaller)
so 2.5×10^{-11} m = .000000000025 meters
or $\frac{25}{10,000,000,000,000}$ or 25 ten-trillonths

This is 25 parts out of ten trillion parts---wow, a very small amount indeed!

TRY MORE LARGE AND SMALL NUMBERS
(and check your answers below)

The Hindus consider "one day in the life of God" to be 4, 320, 000, 000 years. Give:
the word name for this _____
write it in scientific notation _____

This is approximately equal to 1.6×10^{12} human days. How many days is that as a numeral?
_____ and expressed as word name _____

"An atom is one of the basic units of matter. Everything around us is made up of atoms. An atom is a million times smaller than the thickest human hair. The diameter of an atom ranges from about 0.1 to 0.5 nanometers." reference

A nanometer is a billionth of a meter or a millionth of a mm. Write each in scientific notation:

_____x_____m and _____x_____mm

Here's a great question: ***Are there more grains of sand on all the beaches on earth than there are stars in the known universe?***

There are between 100 billion and 400 billion stars in our galaxy the Milky Way (1×10^{11} or 4×10^{11}). There are about 1×10^{11} galaxies in the universe. Multiplying the two we can just add the

FOR ANSWERS TO THIS PAGE;
ANOTHER WKST ON SCI. NOTATION