

King of Dumbs

Level: ♣ Newbie

How much is 7×10^{27} ? Huge numbers without fear

Scientific notation, SI prefixes from kilo to quetta, orders of magnitude, log scales and Fermi estimates, explained with grains of sand, in three levels.

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Scan to open the interactive lesson

<https://kingofdumbs.com/en/lessons/huge-numbers>

What you'll learn

- Scientific notation
- SI prefixes, from quecto to quetta
- Orders of magnitude and log scales
- Billion versus the Spanish billón
- Fermi estimation

Symbols you'll meet

E_a subscript: the label underneath (♠) · Σ sum: add them all up (♠) · x_i index i: item number i (♠) · Π product: multiply them all (♠) · $\approx$ approximately equal (♦♦) · $\leq \geq$ less or equal / greater or equal (♠) · $\neq$ not equal to (♠) · $|x|$ absolute value: drop the sign (♠) · $\cdot$ dot: multiply (or dot product) (♠) · $\Rightarrow \Leftrightarrow$ implies / is equivalent to (♠) · 10^{-3} negative exponent: divide (♦♦) · $\log$ logarithm: how many times do I multiply? (♠) · $\lfloor x \rfloor$ floor: round down (♠) · μ mu: micro (a millionth) or mean (♦♦) · $\in$ belongs to (♠) · $\mathbb{R} \mathbb{Z}$ sets of numbers (♠)

Your body holds about **7×10^{27} atoms**. You read it “seven times ten to the twenty-seventh”, and it’s a 7 followed by 27 zeros. The dumb question of this lesson is: **how much is that?**

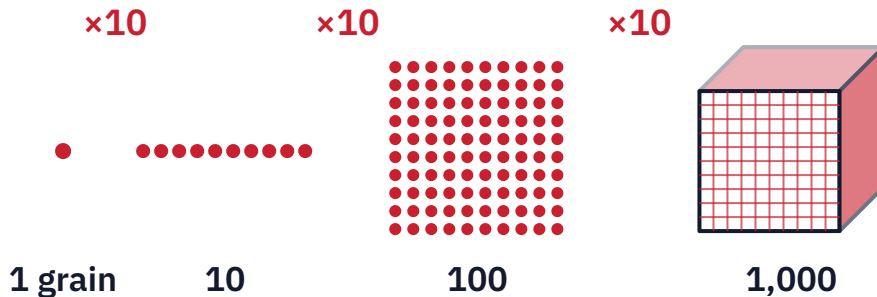
Don’t worry if the number means nothing to you: it means nothing to almost anyone. In an experiment with adults, nearly half put “a million” right in the middle between a thousand and a billion, as if those words were evenly spaced. They aren’t, not even close. This lesson gives you four tools to make huge numbers mean something again: count the zeros, give them names, compare them on the right scale, and estimate them without a calculator.

Pick your card: ♠ if you’re starting from scratch, ♦ if a simple formula doesn’t scare you, ♠ if you want the notation. You can switch at any time.



Counting zeros: scientific notation

Each extra zero is $\times 10$



Take one grain of sand. Put ten in a row: you have **10**. Lay ten rows side by side and you get a slab of **100**. Stack ten slabs and you have a cube of **1,000** grains.

Each time you do that, you multiply by ten, and the number grows **one zero**. That's the whole trick: every extra zero is $\times 10$.

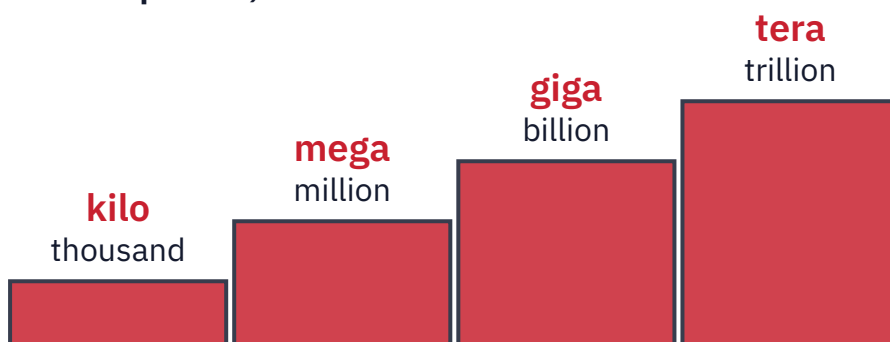
So instead of writing the zeros one by one, you count them. 1,000 has three zeros, so it's written **10^3** ("ten to the third"). A million has six: **10^6** . And 7×10^{27} means "a 7 with 27 zeros after it".

Counting zeros avoids the silliest mistake with big numbers: skipping one without noticing, which makes you wrong by a factor of ten.



Giving them names: prefixes

Each step is $\times 1,000$



Zeros in groups of three have names, and you already use several without thinking:

- **kilo** is a thousand: a kilometre is a thousand metres.

- **mega** is a million: a 12-megapixel photo has 12 million dots.
- **giga** is a billion: a gigabyte is a billion bytes.
- **tera** is a trillion: a one-terabyte drive holds a trillion bytes.

Each step is $\times 1,000$.

And a trap worth knowing if you ever read Spanish: their *billón* is **not** your billion. It means a million millions, a thousand times more. When a translated news story mentions “un billón de dólares”, it may mean a trillion dollars.

The King of Dumbs says:

If a translated story says “un billón de dólares”, count the zeros before panicking. It’s a trillion, not a billion.



Comparing: orders of magnitude and log scales

	a thousand seconds	≈ 17 minutes
	$\times 1000 \downarrow$	
	a million	≈ 12 days
	$\times 1000 \downarrow$	
	a billion	≈ 32 years
	$\times 1000 \downarrow$	
	a trillion	$\approx 31,700$ years

“A million” and “a billion” sound alike. To feel the difference, turn them into time:

- **A thousand seconds** is about 17 minutes: a coffee.
- **A million seconds** is almost 12 days: a holiday.
- **A billion seconds** is almost 32 years: half a lifetime.
- **A trillion seconds** is about 31,700 years.

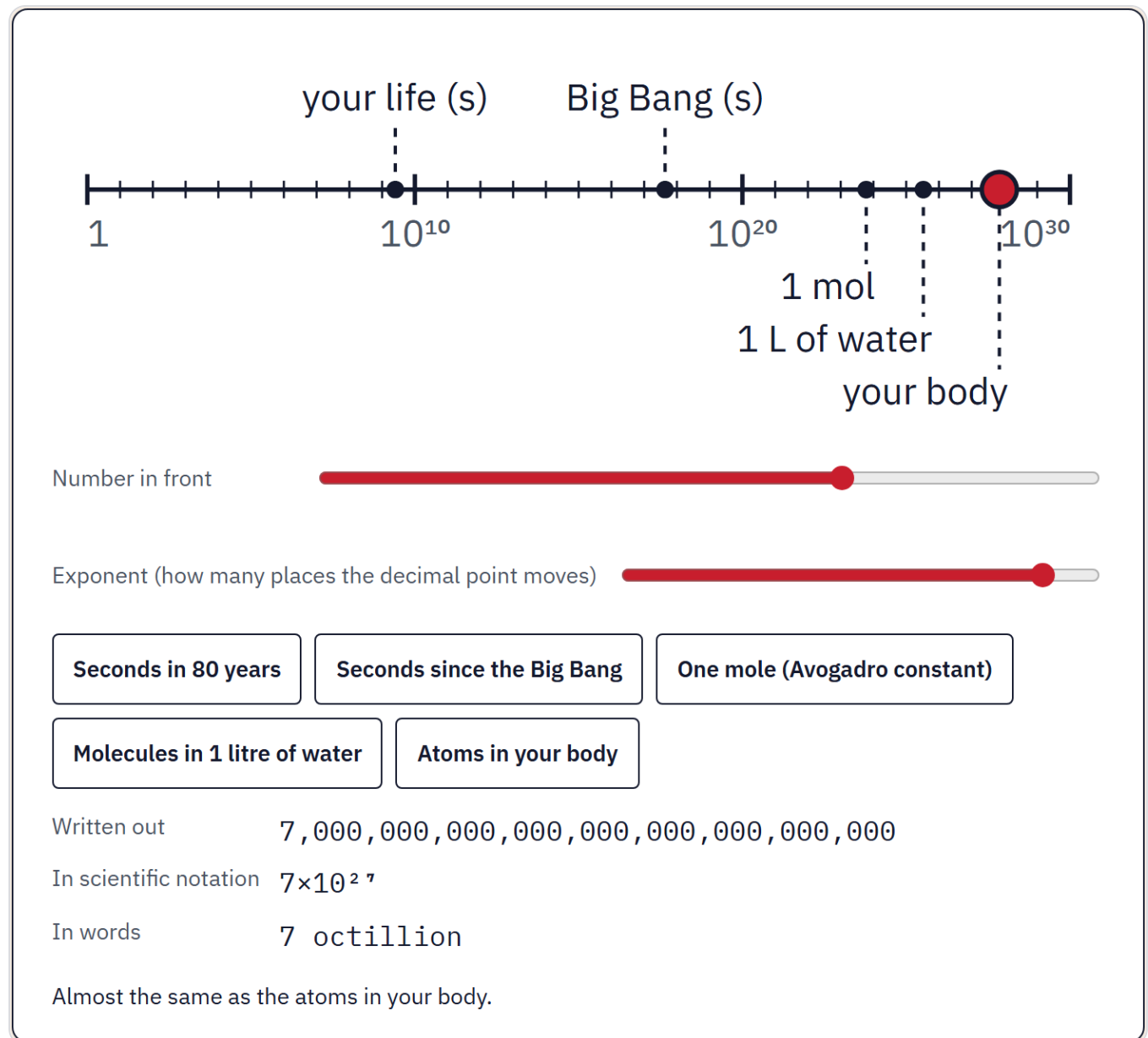
Between a million and a billion there’s the same gap as between a holiday and half a lifetime. Each step of the staircase is $\times 1,000$, however similar the words sound.

That’s why, to compare very different things, you look at **how many zeros** they have, not at the number itself. Two things with the same number of zeros are “the same size”, even if one is twice the other.



Try it: the ladder of zeros

Choose the number in front and the exponent, or jump to a reference. See how it's written out, how it's read and where it lands on the ladder.



Interactive widget. Try it on the web: <https://kingofdumbs.com/en/lessons/huge-numbers>



Estimating without a calculator: the Fermi method

$$\begin{array}{ccc} \approx 1 \text{ beat} & & 80 \text{ years} \approx \\ \text{per second} & & 2.5 \text{ billion s} \end{array} \quad \approx 2.5 \text{ billion beats}$$

How many times does your heart beat in a whole life? You don't need to know to work it out **roughly**:

1. Your heart beats about **once a second**.
2. 80 years is about **2.5 billion seconds**.
3. Multiply: about **2.5 billion beats**.

It isn't exact. Maybe it's 2 billion, maybe 3 billion. But it's certainly not 20 million or 200 billion. You've got **the zeros** right, and for comparing, that's what matters.

This is called a Fermi estimate, after the physicist Enrico Fermi. The trick is to break an impossible question into little pieces you do know, and multiply them.



Final challenge

1. How many zeros does 10^6 have when written out?

- a. 10
- b. 6: it's a million
- c. 60

2. A Spanish news story says «3 billones de dólares». In English, that's...

- a. 3 billion dollars
- b. 3 trillion dollars
- c. 3 million dollars

3. On an ordinary ruler from 0 to a billion, where does a million land?

- a. Around the middle
- b. Stuck to zero: a thousandth of the way
- c. Near the end



In three sentences

1. Each zero is $\times 10$, and scientific notation counts them: 7×10^{27} is a 7 with 27 zeros, about seven octillion atoms, the ones in your body.
2. Prefixes name the zeros in threes (kilo, mega, giga... up to quetta), and in Spanish a *billón* is a million millions, not a billion.
3. To compare or estimate, count zeros: use a log scale when ratios matter, break the problem into factors and check you've got the order of magnitude right.



Sources

- SI prefixes: [NIST, metric prefixes](#) and [BIPM, CGPM 2022, Resolution 3](#) (ronna, quetta, ronto and quecto). Usage rules (inseparable symbol, no compound prefixes, kilogram, powers of 2): [BIPM, SI Brochure](#), section 3. Binary prefixes: [NIST](#).
- Billion, octillion and nonillion in US English: [Merriam-Webster](#). The Spanish billón: [DLE](#) and [Diccionario panhispánico de dudas](#).
- Order of magnitude and reference orders: [OpenStax, University Physics vol. 1, 1.1](#). Fermi estimates: [OpenStax, 1.5](#).

- How adults place large numbers: Landy, Silbert and Goldin, *Cognitive Science* 37, 775 (2013), [doi:10.1111/cogs.12028](https://doi.org/10.1111/cogs.12028).
- Atoms in the human body: Freitas, [Nanomedicine I, 3.1](#), checked against our own calculation from the composition in [WebElements \(U. of Sheffield\)](#) and [CIAAW](#) atomic weights.
- Avogadro constant, exact: [NIST CODATA](#). Limits of a double: [MDN, Number.MAX_VALUE](#).
- Age of the universe (for the widget): Planck 2018, [arXiv:1807.06209](#), 13.787 ± 0.020 billion years, checked against [WMAP \(NASA\)](#), 13.77.

How this lesson was made: researched and written with help from Claude, from the sources above, checked and cross-checked against a second source on 13 October 2026. Numbers without their own link are calculations from them. The drawings are our own.

Answers

1. **b)** 6: it's a million. That's it: the exponent counts the zeros. 1,000,000.
2. **b)** 3 trillion dollars. Right. The Spanish billón is a million millions: your trillion.
3. **b)** Stuck to zero: a thousandth of the way. Exactly. A million is a thousandth of a billion. On a log scale, though, it does land in the middle.

A King of Dumbs lesson, kingofdumbs.com. Offline version; the original, with widgets you can play with, is at: <https://kingofdumbs.com/en/lessons/huge-numbers>

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