

THE SECRETS OF ... SCIENTIFIC NOTATION

Humans are (sort of) in the middle of the universal size scale

- ▣ Astronomers (and other scientists) deal with very big and very small numbers, often related to the size of an object
- ▣ There are 37,200,000,000 cells in the human body – or 3.72×10^{10} cells
- ▣ 2015 US budget was \$3,900,000,000 or $\$3.9 \times 10^9$
- ▣ The diameter of a proton is 0.000000000000000008768 meters or 8.768×10^{-16} m
- ▣ Please watch “Powers of 10” by the Eames Studio:
<https://www.youtube.com/watch?v=0fKBhvDjuy0>

Big Numbers

- ▣ Scientific Notation – Counting Zeros!
 - $1 = 10^0$
 - $10 = 10^1$
 - $100 = 10^2 = 10 \times 10$
 - $1,000 = 10^3 = 10 \times 10 \times 10$
 - $10,000 = 10^4 = 10 \times 10 \times 10 \times 10$
 - $100,000 = 10^5$
 - $1,000,000 = 10^6$ – one million
 - $1,000,000,000 = 10^9$ – one billion
 - $1,000,000,000,000 = 10^{12}$ – one trillion

More Big Numbers

- ▣ $1 \text{ AU} = 1.4960 \times 10^8 \text{ km} = 149,600,000 \text{ km}$
- ▣ ; one astronomical unit
- ▣ $c = 2.9979 \times 10^8 \text{ m/s} = 2.9979 \times 10^5 \text{ km/s}$
- ▣ ; the speed of light
- ▣
- ▣ A practical application: what is the time for light to travel from the sun to the Earth?
- ▣
- ▣ $t = d/c = 1.5 \times 10^8 \text{ km} / 3 \times 10^5 \text{ km/s} = 0.5 \times 10^3 \text{ s} = 5 \times 10^2 \text{ s}$
- ▣
- ▣ $500 \text{ s} / 60 \text{ s/minute} = 8.3 \text{ minutes}$

And Some Small Numbers

- The mass of an electron is a very small number of grams
- $m_e = 9.1094 \times 10^{-31} \text{ kg} = 9.1094 \times 10^{-28} \text{ g}$
- $= 0.000000\dots91094 \text{ g}$
- The mass of a proton is
- $m_p = 1.6726 \times 10^{-27} \text{ kg} = 1.6726 \times 10^{-24} \text{ g}$
- The proton is more massive than the electron – by what factor?
- $m_p / m_e = 1.6726 \times 10^{-27} / 9.1094 \times 10^{-28} = 1.8361 \times 10^3$
- ≈ 2000
- the proton is about 2000 times more massive than the electron

Powers of Ten

- ▣ [Powers of Ten™ \(1977\) - YouTube](#)
- ▣ <https://www.youtube.com/watch?v=0fKBhvDjuy0>

