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Number of atoms in the universe

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Steve's last blog post – [Prime factors: Part 1](#)

In my last blog I looked at the number 'a googol', which is 10^{100} and questioned how it would compare to the number of atoms in the universe. Once students

have an understanding of standard form including multiplication it is reasonably easy to lead your students through this calculation.

It is also reasonable to do it without a calculator using appropriate approximations. The process involves a lot of assumptions and can lead on to a good discussion of the modelling process.

Start with the Sun:

$$\begin{aligned}\text{Mass of the sun} &= 2 \times 10^{30} \text{ kg} \\ &= 2 \times 10^{30} \times 10^3 \text{ g} \quad \text{as } 1 \text{ kg} = 1000 \text{ g} = 10^3 \text{ g} \\ &= 2 \times 10^{33} \text{ g}\end{aligned}$$

Avagadro's number, 6×10^{23} , tells us how many atoms are in 1 g of hydrogen so if we assume that the Sun is *mostly* hydrogen we have:

$$\begin{aligned}\text{Number of atoms in the Sun} &= (2 \times 10^{33}) \times (6 \times 10^{23}) \\ &= 12 \times 10^{56} \\ &= 1.2 \times 10^{57}\end{aligned}$$

If we know assume that all the other bodies in the Solar System (Jupiter, Earth, the other planets, the Moon, other moons, asteroids, etc.) are insignificant compared to the Sun we can approximate the number of atoms in the Solar System as 1.2×10^{56} .

Our galaxy, the Milky Way, contains approximately 100 to 400 billion stars. If we take this as 200 billion or 2×10^{11} stars and assume that our sun is a reasonable average size we can calculate that our galaxy contains about $(1.2 \times 10^{56}) \times (2 \times 10^{11}) = 2.4 \times 10^{67}$ atoms.

The Hubble space telescope tells us that there are about 100 billion or 10^{11} galaxies in the whole universe. So again, if we assume that our galaxy is average, we get that the number of atoms in the universe is about $2.4 \times 10^{67} \times 10^{11} = 2.4 \times 10^{78}$. Internet research gives answers of around 10^{78} to 10^{82} .

This number generally surprises people as they tend to expect it to be a lot bigger. It is quite cool to say that we would need a billion trillion universes to have anywhere near a googol atoms.

Many thanks,

Steve Cavill



Steve Cavill BSc(Hons) PGCE FCIEA has taught maths in both state and independent schools. He spent a few years as an Associate Lecturer for the OU and has written a number of GCSE maths books, workbooks and revision guides as well as being a senior examiner and moderator for GCSE and IGCSE.

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One thought on “Number of atoms in the universe”



SBS

February 22, 2017 at 2:09 pm

Dear Oxfordmaths – I want to correct a minor (major) error here, which is that in fact we know that the Universe is infinite! When you say that Hubble tells us there are some number of galaxies in the Universe, this is in fact only the area of the Universe that we on Earth are able to see. So in fact, the answer to your initial question is straight forward and requires no math 😊 – the number of atoms in the universe is infinity!

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