

THE EXACT MASS OF A KILOGRAM: AVOGADRO'S CONSTANT



Avogadro's constant is named after the Italian scientist Amedeo Avogadro.

Credits: Drawing by C. Sentier, executed in Torino at Litografia Doyen in 1856, from the Edgar Fahs Smith collection, Wikimedia Commons.

URL: https://commons.wikimedia.org/wiki/File:Avogadro_Amedeo.jpg. License: CC-BY.

In 2011, the International Committee for Weights and Measures formalised an approach to redefine the kilogram in terms of Planck's constant. However, this is not the only constant in nature that can be used to arrive at a more accurate definition of the kilogram. Another one that could be used for the same purpose is the Avogadro's constant.

The Avogadro's constant (denoted as N_A) is named after Amedeo Avogadro – an Italian scientist who is most well-known for his contributions to molecular theory. This constant represents the number of atoms contained in one mole of any substance. It's defined as the number of carbon-12 atoms in 12 grams of the element = 6.022×10^{23} . This quantity of carbon-12 constitutes 1 mole of the element. This is also true of every other element – 1 mole of any element consists of 6.022×10^{23} of its atoms.

Since the definition of N_A is related to the mass of a substance, this constant can be used to arrive at a more precise definition of the kilogram. To do this, however, a more precise measurement of N_A would be needed – a goal that members of a worldwide collaboration called the International Avogadro Project have been working towards for more than two decades.

Have we succeeded in getting a more precise value of Avogadro's constant? Find out on page 88.



Siddharth Setlur is a Grade XII student & founder of the non-profit peer-to-peer learning platform (www.vlearn.xyz) who aims to pursue an academic career in theoretical physics and mathematics. He can be contacted at: siddharth.setlur@gmail.com.

Chitra Ravi works at Azim Premji University, Bengaluru.

WONDER WHAT THE EXACT TIME IS?



Our lives today are hugely dependent on accurate time measurements. But, have you ever wondered how time is measured exactly to several decimals of a second?

From age-old methods using celestial, then mechanical, and quartz crystal-based measurements, we have progressed to measuring time using the properties of atoms. When excited with a suitable energy source, electrons of atoms accept and release energy to oscillate between lower and higher energy levels at a constant rate. Since this property, known as their resonance frequency, is constant for atoms of a particular element, it can be used for accurate time measurement.

The adoption of a caesium atom based clock for official measurements of time across the world since the 1960's has ensured precision and accuracy. Caesium (Cs), in Group I of the Periodic Table of Elements has only one electron in its outermost shell. When exposed to intense microwave radiation, this electron in each caesium atom first jumps to a higher energy state and then returns to its original state, emitting photons in the process. Being an atomic property, the duration of each cycle of jumping up and down energy levels is a constant, or takes the exact same amount of time. This is extremely short, though, with an electron completing 9,192,631,770 cycles every second, expressed as Hz or cycles per second. Based on this standard, the International System of Units (SI) has defined one second as the duration of 9,192,631,770 cycles of radiation corresponding to the transition between two energy levels of the caesium-133 atom.