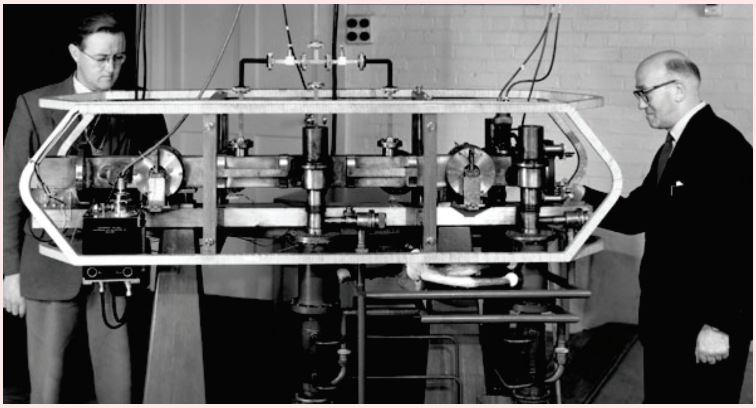
SNIPPETS



Louis Essen and J. V. L. Parry standing next to the world's first caesium atomic clock, developed at the UK National Physical Laboratory in 1955.

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

Most countries have installed their own atomic clocks to keep track of this standard time. India's standard clock is located at The National Physical Laboratory, New Delhi.

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THE EXACT MASS OF A KILOGRAM: COUNTING ATOMS

For more than two decades, members of the International Avogadro Project have been working towards obtaining a more precise (with an error margin of just 20 parts per billion) measurement of Avogadro's constant (denoted as N_A). This project involves researchers at INRiM in Italy, PTB in Germany, NIM in China, METAS in Switzerland, NMIJ in Japan, BIPM in France, NIST in the U.S., and IRMM in Belgium.

These researchers use 94 mm reflective spheres/balls composed of exactly one kilogram of highly enriched (99.9995%) silicon-28 to calculate:

1. The volume of each ball by using a device called an optical interferometer to measure its width (to nanometre precision).
2. The volume of a single atom in the ball by using a technique called X-ray crystallography to measure the volume of a single cubic cell.

The ratio of the volume of the ball to that of one of its atoms provides an estimate of the total number of atoms in the ball.

While N_A is defined in terms of carbon-12, silicon has a special property – it crystallizes into a lattice, with every cubic cell consisting of eight atoms, and each atom taking up exactly the same volume of space. Enrichment helps minimise the presence of isotopes of silicon, ensuring that most atoms in the ball occupy exactly the same space. The smoothness of the ball's surface minimises errors in measurement. Crafted by a master lens maker, this ball may be the 'world's roundest' object!

The world's roundest object?

Credits: National Institute of Standards and Technology, Wikimedia Commons.
URL: https://commons.wikimedia.org/wiki/File:SiliconSphere-Closeup.png. License: CC-BY.

Researchers from the Avogadro project have refined this method to arrive at a value for Avogadro's constant (N_A = 6.02214076 x 10^{23} mol^{-1}) with an uncertainty of just 10 parts per billion. Since it is defined in terms of the mass of a substance, a more precise measurement of this constant could be used to redefine the kilogram. Avogadro's constant is also related to and dependent on Planck's constant. As a result, the re-defined N_A was used to arrive at four measurements of Planck's constant with error margins that were no more than +/- 0.000000020 (or an uncertainty of 20 parts per billion). This satisfied part of the criteria outlined by the International Committee for Weights and Measures.

Have we managed to meet the other criteria listed out by the International Committee for Weights and Measures? Find out on page 93.

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