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Changes in the definition of SI units on May 20, 2019

Based on a long process of international discussions, the SI system is strongly revised: The seven basic units second (s), metre (m), kilogram (kg), ampere (A), kelvin (K), mole (mol), and candela (cd) are now defined by specific values of seven constants.

The official decision by the General Conference on Weights and Measures reads:[1]
Effective from 20 May 2019, the International System of Units, the SI, is the system of units in which:

- the unperturbed ground state hyperfine transition frequency of the caesium 133 atom $\Delta\nu_{Cs}$ is 9 192 631 770 Hz,
- the speed of light in vacuum c is 299 792 458 m/s,
- the Planck constant h is 6.626 070 15 × 10^{-34} Js,
- the elementary charge e is 1.602 176 634 × 10^{-19} C,
- the Boltzmann constant k is 1.380 649 × 10^{-23} J/K,
- the Avogadro constant N_A is 6.022 140 76 × 10^{23} mol^{-1} ,
- the luminous efficacy of monochromatic radiation of frequency 540 × 10^{12} Hz, K_{cd}, is 683 lm/W,

where the hertz, joule, coulomb, lumen, and watt, with unit symbols Hz, J, C, lm, and W, respectively, are related to the units second, metre, kilogram, ampere, kelvin, mole, and candela, with unit symbols s, m, kg, A, K, mol, and cd, respectively, according to Hz = s^{-1}, J = kg m^2/s^2, C = A s, lm = cd m^2 m^{-2} = cd sr, and W = kg m^2/s^3.

This implies conceptual changes in the definitions for four SI units:

1. The **kilogram** is indirectly defined by the value of Planck's constant h with different possible measurement procedures based on quantum effects (such as the Kibble balance or the Avogadro project). Forget about the prototype in Paris from 1889.
2. The **ampere** is defined via the charge of the electron. Forget about forces between current-carrying wires and consequently, μ_0 is *not exactly* 4πx10^{-7} N/A^2 any longer.
3. The **kelvin** is defined via thermal energy with the Boltzmann constant as a proportionality factor. Forget about the triple point of water and acknowledge that statistical thermodynamics rules the game.
4. The **mole** is just a specific number of atoms or molecules. Forget about 12 g of carbon from a time we did not know how large atoms were.

At the time of change, the SI units have the same size, no matter whether the old or new definitions are applied. But deviations will occur in the future, which are of the order of the measurement precision for the constants before the changes took place.

Relevance for electric quantities:
A central motivation for the changes is the fact, that the Josephson constant K_J=2e/h and the von Klitzing constant R_K=e^2/h have specific values in the new SI. This allows for high precision realizations of the volt and the ohm via the Josephson and Quantum-Hall effect. Thereby, the ampere is realized with high precision as volt/ohm. A consistency check can be performed with the more natural (but less precise) realization of the ampere by counting electrons per time in a turnstile (the so called metrological triangle). In fact, these quantum definitions of electrical quantities are the basis for the Kibble balance, where the weight of a mass is measured electrically and quantified in terms of the Planck constant h together with length and time measurements.

1https://www.bipm.org/utils/common/pdf/CGPM-2018/26th-CGPM-Resolutions.pdf