Avogadro and Planck constants, two fundamental pillars of the SI

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In 2018, the General Conference of Weights and Measures reformed the International System of Units [1] by adopting stipulated values of some fundamental physical constants. Today, the kilogram, kelvin, mole, and ampere are related to the Planck (h), Boltzmann (k), and Avogadro (N_A) constants and the elementary charge (e), respectively. The units of time, length, and luminous intensity remain unchanged. They were already defined in terms of constants: the frequency of the radiation emitted in the hyperfine transition of the unperturbed ground-state of the caesium-133, the speed of light, and the luminous efficacy. Yesterday, the kilogram was defined and realised by the international prototype. Today, the kilogram is related to the Planck constant. In this way, it is possible to extend the mass scale above and below 1 kg with accuracies which could not be achieved with the international prototype. The *mise-en-pratique* for the definition of the kilogram [2] recommends two complementary primary experiments for the realisation of the unit of mass. The first experiment, the Kibble electrodynamic balance, measures, through the virtual comparison of electrical and mechanical powers, the ratio between the reference mass and the Planck constant. The second experiment counts the Si 28 atoms, whose mass has been measured in advance, in a macroscopic sphere. In general, each experiment relating a mass to the Planck constant is a primary weighing (at its level of uncertainty). Since 2018, two international key-comparisons of primary methods have been done. The result is that the mass scale has drifted by a few micrograms since the adoption of the new SI.

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[1] 9th edition of the SI brochure, https://www.bipm.org/en/publications/si-brochure
[2] Mise en pratique for the definition of the kilogram in the SI, Appendix 2 of the 9th edition of the SI brochure, https://www.bipm.org/en/publications/mises-en-pratique