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Relativity in Metrology

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The definition (from 1968) of the SI second according to SI brochure [1] is:

The second is the duration of 9 192 631 770 periods of the radiation corresponding to the transition between the two hyperfine levels of the ground state of the caesium 133 atom.

At its 1997 meeting, the CIPM (the Comité International des Poids et Mesures) affirmed that:

This definition refers to a caesium atom at rest at a temperature of 0 K.

Definition of TAI (determines derived time scales such as UTC and GPS) is [1]:

International Atomic Time (TAI) is the time reference coordinate established by the Bureau International de l'Heure on the basis of the readings of atomic clocks operating in various establishments in accordance with the definition of the second, the unit of time of the International System of Units.
TAI is a coordinate time scale defined in a geocentric reference frame with the SI second as realized on the rotating geoid as the scale unit.

Note that the SI second is local proper time and thus the SI metre is local length by fixing value of speed of light in vacuum (in 1983 by the 17th CGPM - the Conférence Générale des Poids et Mesures).

The metre is the length of the path travelled by light in vacuum during a time interval of 1/299 792 458 of a second.

Note that definitions in French are official and e.g. interpretations of the vacuum may differ.
In [2] authors show that by replacing the definition of the SI kilogram (the mass of the international prototype of the kilogram) relative uncertainties of all fundamental constants will be improved (except for the international prototype). New definition is based on fixing either the Planck constant h or the Avogadro constant N_A values (such as in that case of the speed of light in vacuum). It is more systematic to fix h in my opinion. For this case authors in [2] suggest several wordings but this one is the best of them for me.

The kilogram is the mass of a body at rest whose equivalent energy corresponds to a frequency of exactly $[(299\ 792\ 458)^2/6\ 626\ 069\ 311] \times 10^{43}$ *hertz.*

I suggest this definition:

The gram is the mass of a body at rest whose equivalent energy corresponds to a frequency of exactly $13\ 563\ 926\ 614 \times 10^{37}$ *hertz.*

or better:

The gram is the mass of a body at rest whose equivalent energy corresponds to a time interval of 1/13 563 926 614 x 10^{37} of a second.

(In these cases *h* is not exactly 6.626 069 311 x 10^{-34} Js but 6.626 069 311 000 016 ... x 10^{-34} Js.)
By fixing value of the elementary charge *e* to 1.602 176 532 9 x 10^{-19} C (instead of permeability of vacuum) the Josephson and von Klitzing constants become exact too. And by fixing the Boltzmann constant *k* relation between the second and the kelvin become exact. It is expected that the CGPM in 2011 redefine kilogram, ampere, kelvin, mol and candela.

I think that these wordings are not necessary. By fixing constants all quantities become equivalent to one quantity (the second as some multiple of some transition) and in the framework of relativity they become local (e.g. value of inertial system mass in same inertial system kilogram will be same for all inertial systems - the numerical value {M}=M/[M] for all systems). This shows that "fundamental constants" are "conventional constants" and there is no quantities (in case of natural units fixed values of *c*, *h* and *e* will be set equal to 1 and quantities become indistinguishable). Particle (transition) properties and interaction properties are all that remain to be measurable relative to selected one.

I also suggest that conditions in wordings *at rest*, *at a temperature of 0 K* and *in vacuum* should be replaced by *corrected to rest*, *corrected to 0 K* and *corrected to vacuum* because it is impossible to realize them perfectly. (Standards are steered by means of another effect to simulate this correction. They will never operate under these conditions.)

[1] Bureau International des Poids et Mesures: The International System of Units (SI), http://www.bipm.org/en/si/si_brochure/
[2] I.M.Mills, P.J.Mohr, T.J.Quinn, B.N.Taylor: Redefinition of the kilogram: a decision whose time has come, Metrologia 42 (2005), p. 71-80