

Criticisms of the proposed “new SI”

Theodore P. Hill

Dear Sir,

According to a fair spectrum of international scientists and metrologists, the current proposed redefinitions of the mole, the kilogram, and other SI units by the Consultative Committee for Units (CCU) to the Comité International des Poids et Mesures [1] contain serious flaws. Among the basic criticisms are the following:

1. The proposed redefinition of the mole is confusing, unteachable, and/or just wrong [2–6].
2. The proposed redefinition of the mole violates a basic compatibility condition relating it to the kilogram and the dalton [4].
3. The proposed redefinition of the kilogram relies on both special relativity and quantum mechanics and thus is not “comprehensible to students in all disciplines”(see p. 228 in [7]), nor even readily understandable to the majority of scientists and metrologists [3, 6].
4. The proposed redefinition of the kilogram requires the introduction of a new quantum–mechanical current standard [8].
5. The proposed redefinition of the kilogram entails a numerical constant of the order of 10^{41} , which is unrealistic physically [3].
6. The proposed redefinition of the kilogram is based on an artificially created complex electromechanical device (the Watt balance), which is not “a comparatively easy-to-use apparatus that can enable the experimental realization of the new definition of the kilogram with the appropriate uncertainty at any place at any time by anyone” (see p. 238 in [7]) and is not proportional to a real physical mass [2–4, 6, 9, 10].
7. The proposed redefinitions of the SI units are inconsistent and/or circular; for example, the unit amount of substance involves the kilogram, the second is defined in terms of the kelvin and the kelvin in terms of the second, and without the availability of the derived real units joule and watt, the kilogram, kelvin, and candela cannot be realized [2, 5, 6].
8. The proposed “explicit-constant” redefinitions of the SI units are based on imperfect physical laws and equations that require correction factors; for example, there is concrete evidence that the fine-structure constant, and hence Planck’s constant, may vary in time and location [4, 6, 8, 11].

The BIPM website for the New SI proclaims its goal “to encourage communication, awareness, and debate on the possible revision of the SI”. However, colleagues and I have been posing such questions, without success, directly to the proponents of the New SI and the head of the CCU for more than 4 years. It is now time to enter these criticisms, and hopefully their responses, into the open and permanent written scientific record. I wish to express my deep gratitude and appreciation to the Editor for this opportunity.

References

1. BIPM draft of new SI (2010) http://www.bipm.org/utis/common/pdf/si_brochure_draft_ch2.pdf
2. Feller U (2011) The International System of Units—a case for reconsideration. *Accred Qual Assur* 16:143–153
3. Hill TP, Miller J, Censullo AC (2011) Towards a better definition of the kilogram. *Metrologia* 48:83–86
4. Leonard B (2011) Why the invariant atomic-scale unit, entity, is essential for understanding stoichiometry without , ,Avogadro anxiety“. *Accred Qual Assur* 16:143–153
5. Pavese F (2011) Some reflections on the proposed redefinition of the unit for the amount of substance and of other SI units. *Accred Qual Assur* 16:161–165
6. Price G (2011) A skeptic’s review of the New SI. *Accred Qual Assur* 16:121–132
7. Mills I, Mohr P, Quinn T, Taylor B, Williams E (2006) Redefinition of the kilogram, ampere, Kelvin, and mole: a proposed approach to implementing CIPM recommendation 1 (CI-2005). *Metrologia* 43:227–246
8. Khrushov A (2010) Fundamental problems in metrology: possible definition of the unit of mass and fixed values of the fundamental physical constants. *Meas Tech* 53:583–91
9. Kononogov S, Khrushov A (2006) Fundamental problems in metrology: scope for replacing the prototype kilogram by an atomic mass unit. *Meas Tech* 10:953–956
10. Rusch P (2011) “Redefining the kilogram and mole”, ACS Comment, Chemical and Engineering News Digital Edition. <http://www.cen-online.org>, May 30
11. Barrow J, Webb J (2005) Inconstant constants: do the inner workings of nature change with time? *Sci Am* 292(6):57–63