IUPAC

Advancing Worldwide Chemistry

Revision of the definition of the mole

The position of the Analytical Chemistry Division of IUPAC with some thoughts on ‘teachability’

Disclaimers

- Definition of mol and kg given here are from Division V (Analytical Division) formulated in Antwerp, February 2012, reaffirmed Istanbul, August 2013, and Pécs March 2014.
- IUPAC policy is to support the CCU proposals, which was passed by ICTNS and then the Bureau in Glasgow 2009
- Anything else is a personal view and has no official status.

The Analytical Division view (10 Aug 2013)

- "The position of the ACD was based on that of the CIAAW."
- "In particular there was support for a definition of the Avogadro number that recognises it as a scaling factor of individual entities."

The mole

The ACD recommends the following future definition of the mole:

The mole, symbol 'mol', is a number of entities equal to 6.022 14x yz $\times 10^{23}$ entities exactly

Note 1: The entities must be specified

Note 2: The proposed definition does not require an associated quantity other than '1'. However to maintain continuity with the present ISQ, the present quantity 'amount of substance' is renamed 'chemical amount', and the mole be also recognised as the unit of chemical amount.

Note 3: The International Vocabulary of Metrology (VIM) notes (1.4, Note 3) 'Number of entities' can be regarded as a base quantity in any system of quantities.

The mole … 2

- The ACD **requests** that any decision on redefinition of the mole be deferred until full consideration is given to the interests of the chemical and isotopic measurement communities.

Unit of mass

If the unit of mass is no longer to be tied to the mass of an object (the International Prototype of the kilogram), the ACD proposes that the unit of mass be the gram, symbol ‘g’.

Together with the fixed value of the Avogadro number, the dalton could serve to redefine the gram. The ACD recommends the following future definition of the gram:

The gram, unit of mass, symbol ‘g’, is one twelfth (1/12) of the mass of 6.022 14x yz $\times 10^{23}$ atoms of ^{12}C in their nuclear ground state.

Amount of substance

- A concept that has troubled chemists.
- Most do not use the quantity amount of substance at all
- Most consider N_A as Avogadro's number (with unit '1', not mol^{-1})
- Most describe *n* mol as "*n* number of moles"

Evidence

- A review of 18 first year university general chemistry text books published 1989 – 2014
- 14 publishers Europe and USA (writing in English)

Results

- Amount of substance in index ➢ 3/18
- Amount of substance referred to in text correctly ➢ 4/18
- N_A correctly identified as the Avogadro constant with unit mol^{-1} ➢ 4/18
- Correct SI definition of mole ➢ 0/18

Quotes

- “The mole is an SI base unit. The physical quantity to which it refers is called the “amount of substance”. However, practicing chemists commonly prefer to talk about “the number of moles.” Take the advice of your instructor on whether or not to use the official term.” (Atkins)
- “amount of *a* substance” (4 texts)
- “Mole: The amount of a substance whose mass in grams is numerically equal to its molecular or formula weight.” (McMurray)

Should concept a-o-s be moved to mass? … leaving chemists to count their molecules

- "Beyond the God Particle" by Nobel Laureate Leon Lederman and Christopher T. Hill (Prometheus Books, 2013)
- "mass is a measure of quantity of matter" (p82, p243)