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LETTERS TO THE EDITORS

# Gleaning the Cube

To the Editors:

"An Exact Value for Avogadro's Number" by Ronald F. Fox and Theodore P. Hill (*Macroscope,* March-April) makes the suggestion that Avogadro's number be redefined as an integer, thus emulating the philosophy behind the physics community's definition of fundamental units of time and distance.

I wish to point out that the Committee on Nomenclature, Terminology and Symbols of the American Chemical Society, which I chair, has been advocating this change, recently submitting a formal proposal to the American Chemical Society for endorsement. Additionally, the Committee is about to seek the support of the American Physical Society and the National Academy of Sciences for the change. It will be a pleasure to add Drs. Fox and Hill's commentary to our bibliography.

We differ from their suggestion in just one regard, though. Our proposed integer is exactly divisible by 12 so that the gram (and kilogram, of course) is naturally accommodated. That is, 12 grams of carbon-12 is the mass of Avogadro's number of atoms. There would no longer be a need for the platinum-iridium artifact in Paris to serve as the kilogram's standard. Additionally, much of what seems to confuse many students about the mole in introductory courses will be dampened.

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To the Editors:

My concept of the mole leads me to a different conclusion than the one chosen by Ronald M. Fox and Theodore P. Hill. While the cubic structure envisioned by the authors is consistent with the current definition of Avogadro's number, the functional use of the mole is as a concept to express the stoichiometric relationships in chemical reactions.

Choosing a cubic number based on the shape of a volume is not really physically significant in the definition of a number that deals with units, not shapes or volumes. Furthermore, although volumes are described cubically, they may actually be measured in any number of different shapes.

When teaching what a mole is to students, I have found it useful to liken it to a quantity such as a dozen. The notion that one dozen card tables require four dozen chairs is similar in concept to combining two moles of hydrogen with one mole of oxygen.

In that sense I agree with the idea of defining a real integer for Avogadro's number but prefer the "round" number of 602,214,150,000,000,000,000,000. By the author's own admission, it is a better approximation of the best experimental value.

The physical significance of the dozen is obvious; it is exactly the number of eggs that will fit in an egg box. The physical significance (however arbitrary) of the "round" Avogadro's number will be as obvious once we create the theoretical one-mole container with the right number of niches for each molecule. By convention, the actual construction of such a container is left as an exercise for the student.

Joshua Morowitz
Christiansted, U.S. Virgin Islands

Drs. Fox and Hill respond:

If carbon-12 is expected to remain the standard, and the scientitific community therefore prefers an integer divisible by 12, then we suggest using $84{,}446{,}886^3$, the perfect cube in our list that is two atoms shorter on each side than the "closest cube." Then 1 gram would be the mass of exactly 18 $\times 14{,}074{,}481^3$ carbon-12 atoms. Consequently, 1 amu would be exactly $1/(2 \times 3^2 \times 1{,}667^3 \times 8{,}443^3)$ gram, and 1 mole of any entity would be exactly $84{,}446{,}886^3$ of those entities. Another of the 10 cubes we listed, $84{,}446{,}892^3$, is even divisible by $12^3$ but is not as close to the NIST central value.

The number 602,214,150,000,000,000,000,000 is certainly "round"—using human-hand-based decimal notation. But modern digital computers use binary arithmetic and that 79-bit number is especially cumbersome in binary or hexadecimal arithmetic, whereas, in hexadecimal form, $84{,}446{,}886^3$ is simply $5088EA6^3$.