

The Origin of the Mole Concept

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Question

What is the origin of the mole concept?

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Answer

The term “molar” (from the Latin *moles*, meaning “a large mass”) was first introduced into chemistry by the German chemist, August Wilhelm Hofmann (figure 1), around 1865 (1). It was originally intended to indicate any large macroscopic mass, in contrast to a submicroscopic or “molecular” mass (also derived from moles by attaching the Latin suffix *-cula*, meaning “small or

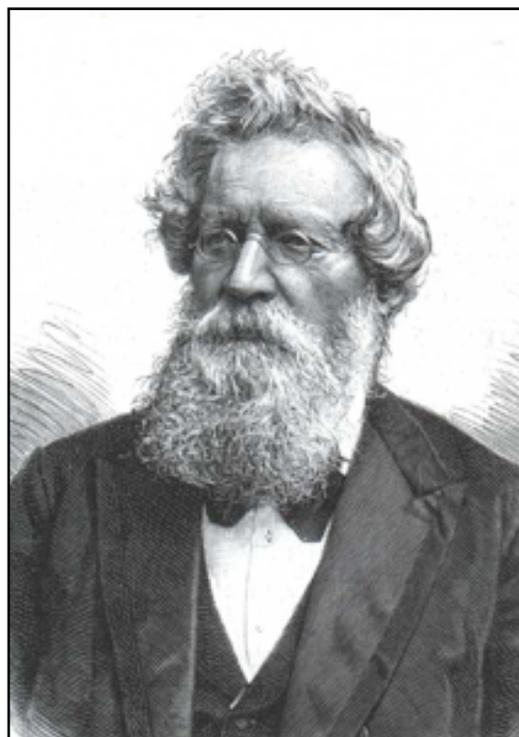


Figure 1. August Wilhelm Hofmann (1818-1892).



Figure 2. Wilhelm Ostwald (1853-1932).

diminutive”). In other words, rather than talk about macroscopic versus microscopic, one talks about molar versus molecular. This particular use of the term molar also gained currency in the physics literature, where it was in common use at least through the 1940s.

The more restricted use of the term molar to mean, not just any macroscopic sample, but rather one whose mass in grams directly reflects the mass of its constituent molecules, as well as use of the noun “mole,” is usually attributed (2) to the German physical chemist, Wilhelm Ostwald (figure 2), and appears in several of his textbooks written around the turn of the 20th century (3). Ironically, Ostwald’s use of the term was connected with his attacks on the atomic-molecular theory and his attempt to establish a macroscopic alternative for discussing the laws of stoichiometry (4).

Although use of the volume definition of a mole for gases (22.4 liters at STP) appears relatively early in

20th-century introductory American textbooks, the explicit interconversion of grams and moles as part of standard stoichiometry problems does not appear to have been common before the 1950s (5, 6).

As a linguistic footnote, it is interesting to observe that the term mole or *mola* was also used by the Romans to denote the heavy stones used to construct harbor breakwaters and for millstones. The connection between the latter usage and the act of grinding also accounts for such usages as molar teeth.

Literature Cited

1. A. W. Hofmann, *Introduction to Modern Chemistry, Experimental and Theoretic*, Walton and Maberley: London, 1865, pp. 140-141, 150.
2. M. Trautz, *Lehrbuch der Chemie*, Vol. 1, Vereinigung Wissenschaftlicher Verleger: Berlin, 1922, p. 56.
3. W. Ostwald, *Grundlagen der anorganischen Chemie*, Engelmann: Leipzig, 1900.
4. W. Ostwald, *The Fundamental Principles of Chemistry*, Longmans, Green & Co: London, 1909.
5. S. Benson, *Chemical Calculations*, Wiley: New York, NY, 1952, Chap. IV.
6. H. V. Anderson, *Chemical Calculations*, McGraw-Hill: New York, NY, 1955, Chap. IX.

Do you have a question about the historical origins of a symbol, name, concept or experimental procedure used in your teaching? Address them to Dr. William B. Jensen, Oesper Collections in the History of Chemistry, Department of Chemistry, University of Cincinnati, Cincinnati, OH 45221-0172 or e-mail them to jensenwb@ucmail.uc.edu

2009 Update

Since writing the original column several related articles on this subject in Japanese have been brought to my attention:

H. Onishi, "The Mole: Past and Present," *Kagakushi*, **2002**, *29*, 254-258.

H. Onishi, "Early Usage of the Mole, Loschmidt's Number and Avogadro's Constant (or Number)," *Kagakushi*, **2004**, *31*, 35-39.

I have also since encountered the abbreviation "Mol." for a gram-molecular weight of substance in several earlier German publications, though this appears to have been an abbreviation for "molecular weight" rather than for the word "mole." See, for example:

A. Horstmann, "Theorie der Dissociation," *Ann. Chem. Pharm.*, **1873**, *170*, 192-210.