How and When Did Avogadro's Name Become Associated with Avogadro's Number?

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Question

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Answer

Though Avogadro's hypothesis that equal volumes of gases at constant temperature and pressure contain equal numbers of molecules became the established basis of molecular and atomic weight determinations shortly after the publication of Stanislao Cannizzaro's (1826-1910) famous pamphlet of 1858 (1), it did not become a common index entry in American textbooks until the 1880s (2). The reason for this 25-year lag was that the topics of molecular weight determinations and quantitative gas-law problems were considered too advanced for elementary texts prior to this period.

Much the same time lag is found in the case of Avogadro's constant or number. Avogadro, of course, had nothing whatsoever to do with determining this number. Rather, interest in calculating the actual number of molecules in equal volumes of gas at STP was a development of the kinetic theory of gases in the last half of the 19th century (3). The resulting value was usually reported as the number per milliliter of gas, rather than per gram molecular weight or mole of gas, and became known as Loschmidt's number in honor of the Austrian chemist, Joseph Loschmidt (1821-1895), who first suggested a method of estimating it in 1865 (4).

Both the shift to the chemically more relevant magnitude per mole of gas at STP and the association of Avogadro's name with the resulting value occurred in the first decade of the 20th century and are largely associated with the work of French physical chemist, Jean Perrin (figure 1), on the kinetic theory of Brownian motion. In his initial papers of 1908 Perrin

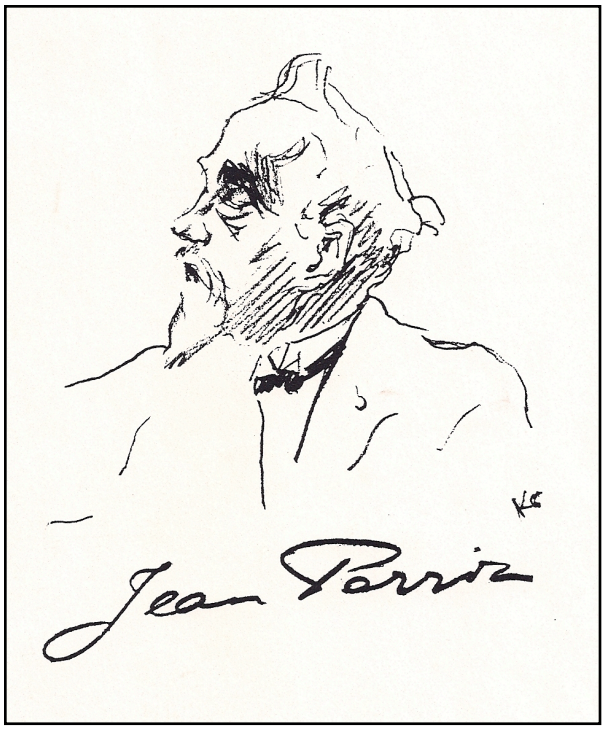

Figure 1. An autographed caricature of Jean Perrin (1870-1942) by Elisabeth Kern, c. 1930.

simply referred to the constant as the number of particles per "molecule-gramme," but in a massive review published in 1909 he proposed naming the constant in honor of Avogadro (5):

This invariant number N is a universal constant, which may, with justification, be called Avogadro's constant.

a suggestion which he further popularized in his two very successful books: *Brownian Movement and Molecular Reality* (1910) and *Les atomes* (1913) (5, 6).

Though Sir William Ramsay saw fit to mention Perrin's proposal in a popular book on chemistry for the layman as early as 1912 (7), American chemistry texts were slow to follow his lead, in large part because the topic was considered too advanced for introductory

students. As a result, the index entry "Avogadro's Number" does not become common in American college texts until the 1930s (8), and is rare in high school texts prior to the 1950s (9).

Literature Cited

1. S. Canizzaro, "Sunto di un corso di filosofia chimica," *Il Novo Cimento*, **1858**, *7*, 321-366. An English translation is found in S. Cannizzaro, *A Sketch of a Course of Chemical Philosophy*, Alembic Club Reprint No. 18: Livingstone: Edinburrgh, 1966.

2. This statement is based on a survey of texts in the Oesper Collections. Thus it does not appear as an index entry in the 1869 and 1875 editions of the popular text by Cooley, but it does appear in the 1886 edition. See L. C. Cooley, *A Guide to Elementary Chemistry for Beginners,* Ivion & Blakeman: New York, NY, 1886.

3. See, for example, A. D. Risteen, *Molecules and the Molecular Theory of Matter*, Ginn: Boston, MA, 1895, p. 148.

4 L. Loschmidt, "Zur Grosse der Luftmolecküle," *Sitz. K. Akad. Wiss. Wien: Math-Naturwiss. Kl.*, **1865**, *52*, 395-413.

5. J. Perrin, "Mouvement brownien et réalité moléculaire," *Ann. chim. phys.,* **1909**, *18*, 1-144. The quote is on p. 16. This review also appeared in English as the book: J. Perrin, *Brownian Movement and Molecular Reality*, Taylor & Francis: London, 1910.

6. See J. Perrin, *Les atomes*, Alcan: Paris, 1913. An English translaton appears as J. Perrin, *Atoms*, Constable: London, 1916.

7. W. Ramsay, *Elements and Electrons*, Harper: New York, NY, 1912, p. 110.

8. Thus the 1921 edition of the popular college text by Harry Holmes has no index entry, and the 1930 edition mentions it only in a problem at the end of a chapter. Only in the 1936 edition is it fully integrated in the text. See H. Holmes, *General Chemistry*, 3rd ed., Macmillan: New York, NY, 1936. Likewise, it is missing from the 1918, 1926, and 1932 editions of Joel Hildebrand's text, appearing only in the 4th edition of 1940. See J. H. Hildebrand, *Principles of Chemistry*, 4th ed., Macmillan: New York, NY, 1940.

9. Thus there is no index entry for the 1931, 1942, and 1954 editions of the popular high school text by Dull, et al. It does not appear until the 1958 edition. See C. E. Dull, H. C. Metcalfe, J. E. Williams, *Modern Chemistry*, Holt, Rinehart & Winston: New York, NY, 1958.

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

Update

An earlier and more comprehensive survey of the progressive introduction of Avogadro's number into the introductory chemistry textbook may be found in:

* R. M. Hawthorne, "The Mole and Avogadro's Number: A Forced Fusion of Ideas for Teaching Purposes," *J. Chem. Educ.,* **1973**, 50, 282-284.