PRESIDENTIAL SYMPOSIA
ACS SPRING NATIONAL MEETING
SAN FRANCISCO 2010

SUNDAY, MARCH 21

1:30-3:30 PM
The Kilogram and the Mole (Cosponsored by NTS)
The Moscone Center, Esplanade Ballroom 306

P. F. Rusch**,** *Organizer, Presiding*

1:30 Introductory remarks
1:40 An introduction to the international system of units, **R. L. Watters, Jr.**
2:10 Impact on Mass Spectrometry of Changing the Definition of the Kilogram to be Based on a Newly Created (Agreed to) Avogadro's Constant, **Patrick R. Jones**
2:40 Kilogram and mole: definitions, standards and artifacts, **P. J. Karol**
3:00 Panel discussion

Speaker information:
Note: Ambler Thompson Technology Services NIST replaced Robert Watters

Symposium Title	The Kilogram and the Mole
Symposium Date	March 21, 2010
Speaker's Full Name	**Robert L. Watters, Jr.**
Institution/Company	National Institute of Standards and Technology
Address	Measurement Services Division National Institute of Standards and Technology 100 Bureau Drive MS2300 Gaithersburg, MD 20899-2300
Phone Number	301-975-4122
Email	robert.watters@nist.gov
Paper Title	An introduction to the international system of units
Abstract	When we measure a quantity, the result is expressed as some number and an associated unit. Units can be defined in many ways, and throughout history numerous measurement systems have been developed with a myriad of defined units. In 1954

the 10th General Conference on Weights and

Measures (CGPM, *Conférence Général des Poids et Mesures*) decided that a basic set of quantities for time, length, mass, electric current, thermodynamic temperature, and luminous intensity should be expressed in terms of the units second, meter, kilogram, ampere, degree Kelvin (later renamed the kelvin), and candela, respectively. The 11th CGPM formally defined this as the International System of Units. Since then, the CGPM has modified the SI a number of times to reflect advances in science and technology. Notably, in 1971 the seventh base unit, the mole (mol), was added. The SI has become the modern metric system of measurement.

The one remaining physical artifact-based unit is the kilogram. It is currently defined as the unit of mass equal to the mass of the international prototype of the kilogram kept at the Bureau International des Poids et Mesures (BIPM). Recent efforts at redefining the kilogram in terms of invariant physical phenomena offer an opportunity to consider a redefinition of the entire SI. The proposed new SI differs from the current SI mainly in the way the kilogram, ampere, kelvin, and mole are defined and in the wordings of all seven of the SI base unit definitions.

The history of how the definitions of the seven SI base units have changed over time will be described, as well as how the current and proposed new set of definitions work together to fix the values of seven fundamental constants.

Symposium Title	The Kilogram and the Mole
Symposium Date	March 21, 2010
Speaker's Full Name	**Patrick R. Jones**
Institution/Company	Pacific Mass Spectrometry Facility
Address	Chemistry Department College of the Pacific University of the Pacific 3601 Pacific Ave. Stockton, CA USA 95211
Phone Number	209-946-2442
Email	pjones@pacific.edu
Paper Title	Impact on Mass Spectrometry of Changing the Definition of the Kilogram to be Based on a Newly Created (Agreed to) Avogadro's Constant
Abstract	Most chemists work with masses on the MKS scale; mass spectrometrists work with masses on the atomic scale. The relationship between the atomic scale and the MKS scale is based on the mole, i.e., the amount of substance of a system which contains as many *elementary entities* as there are atoms in 0.012 kilograms of carbon-12. A mole is said to contain an Avogadro's number *of elementary entities*. Various values of Avogadro's number have been determined, all of which are somewhat >6.02214×10^{23}. There is now a proposal to change the definition of a kilogram to being based on a fixed value representing Avogadro's number, which would be a constant. This means that the mass of ^{12}C would become a variable. There would no longer be relative atomic masses for the various nuclides, and individual exact mass values on the atomic scale would be continually changing as the measure of mass of Avogadro's constant became more precise. Elemental compositions determined by mass spectrometry would become ambiguous. As mass spectrometry becomes able to make measurements of ions with increasing numbers of atoms, the problem of ambiguous masses becomes exacerbated.

Symposium Title	The Kilogram and the Mole
Symposium Date	March 21, 2010
Speaker's Full Name	**Paul J. Karol**
Institution/Company	Carnegie-Mellon University
Address	Department of Chemistry 4400 Fifth Avenue Pittsburgh PA 15213
Phone Number	412-268-3142
Email	pk03@andrew.cmu.edu
Paper Title	Kilogram and mole: definitions, standards and artifacts

Abstract

The kilogram standard is based on an international Pt-Ir prototype. Everyone agrees using such an artifact for a basic unit (mass) is unacceptable and, in fact, fraught with problems (changes over time). Proposed alternatives to the kilogram standard, discussed by others, involve the Watt balance or silicon sphere. Ultimately, the International Bureau of Weights and Measures (BIPM) will soon decide on a new definition. One highly favored proposal uses Planck's constant and NIST Watt balance results. In contrast, chemists and chemistry-related scientists have traditionally preferred the relationship between mass and number (amount of substance) as that embodied in the statement "Avogadro's number of carbon-12 atoms has a mass of exactly 12 grams". This Symposium contribution will present arguments as to how and why it is not only preferable to maintain the latter infinitely precise definition, but why the alternative is opaque, contradictory to its objective, and counterproductive in chemical education.