# PREFACE

## 100th Anniversary Edition

### A Heritage of High-Quality Data
### Looking to the Future

As we finish the 100th Edition, I am already planning for the future, thinking of how do we maintain the quality, completeness of coverage, and diversity that has characterized the *CRC Handbook of Chemistry and Physics* all these years. As I look at the developments of the Information Revolution, it is increasingly clear that the need for the *CRC Handbook* is as great as it has ever been. With the advent of knowledge discovery, artificial intelligence, data mining, and advanced modeling becoming routine tools in chemistry and physics, quality data are more important than ever. What are we doing to celebrate the achievements of the first one hundred editions?

- First, we continue to expand the coverage, currency, and quality of our data, with major updates to a number of important data sets in thermophysics, atomic and molecular physics, analytical chemistry, and neutron science. These updates ensure that data tables contain the latest consensus data on these topics.
- Second, we have increased the discoverability and usability of the *CRC Handbook* with new introductions that detail the contents more clearly and are more easily indexed by major search engines. We also have developed new user guides to show how the chemistry and physics data in the *CRC Handbook* remains relevant to modern undergraduate and high school courses.
- Third, we continue our commitment to use the tools of the Information Revolution – advanced database methods and web technology to ensure the widest possible distribution of the *CRC Handbook*, which is now available 24 hours a day, every day, regardless of user location. In addition, the Online Edition is free from constraints of the printed page and volume size, allowing for expansion of the content without space limitations.

At the same time, it is important to look back at the important impact the *CRC Handbook* has had over the last 106 years, providing hundreds of thousands of students and professional scientists with easy access to high-quality data in a broad range of topics in chemistry and physics. I remember on my first day as a chemical engineering student going with my entire stoichiometry class to the Cornell bookstore and buying a slide rule and a copy of the *CRC Handbook of Chemistry and Physics*. While the slide rule sits unused in my desk drawer, the *CRC Handbook* continues to be an everyday tool.

It is worth noting that in 1913, the date of the first edition, there were only 81 known chemical elements, and the only known fundamental physical particle was the electron. As our knowledge of the physical world has progressed, the *CRC Handbook* has expanded also with information on all 118 identified chemical elements and the numerous fundamental physical particles discovered since 1913. I would also like to mention that 2019 is the 150th anniversary of the publication of Mendeleev's Periodic Table. That classification system transformed our way of organizing knowledge about the physical world, and today is still a major organizing principle for chemical knowledge.

This 100th Edition of the *CRC Handbook* is a tribute to the succession of outstanding editors – W. R. Veazey, the original editor (1913), Charles Hodgman (1914 to 1963), Robert Weast (1964 to 1989), David Lide (1990 to 2009), and Mickey Haynes (2010 to 2016). Their dedication to providing generations of scientists with the highest quality of data is a tradition I hope to continue. A brief history of the *CRC Handbook*, from its beginning to the present, follows on a separate page.

The success of the *CRC Handbook* is very dependent on feedback from its users. The Editor-in-Chief appreciates any suggestions from readers on proposed new topics for the *CRC Handbook* or comments on how its usefulness may be improved in future editions. Please send your comments to john.rumble@hbcp.com.

Numerous international experts make key contributions to the *CRC Handbook*. These contributors are listed on pages immediately following this Preface. Their efforts play a key role in the quality and diversity of the subject matter covered in the *CRC Handbook*. The sound advice and guidance of the Editorial Advisory Board members, who are listed in the front matter, is very much appreciated. Fiona Macdonald, Senior Publisher – Chemical & Life Sciences, CRC Press/Taylor & Francis Group has been of great assistance and support in providing oversight to ensure that the *CRC Handbook* continues to satisfy the needs of the user community. Thanks are also due to Linda Manis Leggio and Pam Morrell for their detailed, cooperative work and extreme care in the production of the *CRC Handbook*. Special thanks are due to David R. Lide and Thomas Bruno for their assistance in support of the Editor-in-Chief.

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## *CRC Handbook of Chemistry and Physics*
## 100th Anniversary Edition

### A Brief History*

In 1913, Arthur Friedman, then owner of a chemical supply company, the Chemical Rubber Company, realized his idea for a single-volume reference book of 116 pages containing data on chemistry, physics, and other closely allied sciences. To quote from the original 1913 Preface,

> In compliance with the requests of hundreds of our friends for a small but comprehensive book of reference on chemical and physical topics, we have designed and compiled this Pocket Manual of Chemistry and Physics.
>
> We shall feel amply rewarded for our effort and expense if this volume proves to be of use and convenience to the profession whose support has been a conspicuous factor in the growth of our establishment. The material here included has been carefully selected by W. R. Veazey, Ph.D., Chemistry Department, Case School of Applied Science. The compiler has been guided in his selection by suggestions of more than a thousand members of high standing in the Chemical and Physical profession. We desire to express our appreciation and thanks to the many persons who have co-operated with us in the preparation of this book.

Professor Veazey ended his editorship in 1914, and the second editor of the *CRC Handbook* was Professor Charles Hodgman of the Department of Physics at Case School of Applied Science, later to become Case Western Reserve University. Professor Hodgman continued to edit the *Handbook*, occasionally with co-editors, until 1963. He was succeeded by Professor Robert Weast who was a professor of chemistry, also at Case Western Reserve University.

In 1990, David Lide, formerly of the Standard Reference Data Program at the National Institute of Standards and Technology (NIST), formerly the National Bureau of Standards, became the fourth editor, followed in 2010 by Mickey Haynes, also from NIST. In 2017, John Rumble, Jr., another NIST data graduate, became editor.

As mentioned in the Preface, the evolution of scientific knowledge since 1913 has resulted in an explosion of high-quality measurements of the properties of virtually every aspect of the physical world. The property data resulting from these measurements are of great importance far beyond the original measurement communities, and these data are used to model behavior and predict performance in every field of science and engineering. Consequently, the importance of the *CRC Handbook* continues to grow as an authoritative source of reliable data.

The *CRC Handbook* has changed over time to meet the demands of the user communities. Older data were replaced with updated values, new topics have been added continuously, and the format of the Print Edition was improved for readability. In the last decade, the digitization of the *Handbook* was completed, and a modern database now supports automated publication of the Print Edition, as well as production of the Online Edition, which continues to grow in popularity.

From the beginning, the editors of the *CRC Handbook* have placed high emphasis on data quality. Experts in each field are enlisted to select the most accurate measurements from the literature and to document the sources. When critically evaluated data are available from data centers in fields such as thermodynamics, atomic physics, crystallography, particle physics, and others, those values are adopted by the *Handbook*. In the modern electronic era, when large amounts of physical and chemical data of unknown provenance and unverified accuracy are deposited on the Internet, we continue to maintain the role of the *CRC Handbook of Chemistry and Physics* as the most reliable data source for scientists and engineers.

**John Rumble, Jr.**
**David R. Lide**
**Fiona Macdonald**
*January 2019*

* Parts of this history have been adapted from Prefaces in previous editions of the *CRC Handbook*.