Preface

To the Expanded English Edition

After the publication of the Chinese edition of the book, some friends and colleagues encouraged me to translate the book into English so that the book could have a wider readership. This motivated me to do so.

In this expanded English edition, some sections used for the Chinese edition have been rewritten, new sections have been added, and the original Chapter 11 has been expanded and split into two chapters – Chapters 11 and 12. Also, more problems have been added at the end of each chapter so that the reader can have more problem choices. An appendix, added at the end of the text, explains how to derive the approximations and evaluate the integrals used in the text.

More microscopic thermodynamics topics are included in the text. The grand canonical ensemble and the associated grand partition function are introduced in Chapter 10. The grand partition function approach is then applied in Chapter 12 to derive the distribution functions for the quantum ideal gases, which cannot be obtained by using the partition function approach. The topic of ferromagnetism which uses a simple mean field theory Ising model is discussed in Chapter 11. In Chapter 12, thermodynamic properties of ideal quantum gases near absolute zero are studied in more detail.

This expanded English edition was carefully proof-read by both National Central University (Chungli, Taiwan) physics professor J. M. Nester and his wife Debbie Nester. Professor Nester not only refined the English of the text, but in several places also made valuable suggestions about the subject matter.

I appreciate very much their help. Without their effort, the book would not be in the present readable form. Finally, I would like to thank Dr. K. K. Phua of the World Scientific Publishing Company who supported the publication of this edition.

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Preface

To the Chinese Edition

This book is based on lecture notes which the author had written for the undergraduate course "Thermal Physics", which the author has taught during recent years at the National Taiwan University. It is hoped that this book would provide an additional choice as a textbook or a reference book for professors and students who are going to teach or to study the course *Thermal Physics* or *Thermodynamics*.

It is written in Chinese for the convenience of Chinese reading students. However, all the chapter and section titles, and the scientific terminologies are also given in English. This is because at present, and in the foreseeable future, English is the most common language in the physics community, as well as in many other professional communities. Therefore, it is important for the student to be familiar with English terms and terminologies when they are learning a new subject in physics.

There are eleven chapters in the book. Seven of them (Chapters 1, 2, and 4–8) concern macroscopic classical thermodynamics, and the other four (Chapters 3 and 9–11) are about microscopic statistical thermodynamics. In Chapters 1 and 2, the important zeroth, first and second laws of thermodynamics are introduced; they are the basis of thermodynamics.

In these chapters, two quantities, temperature and entropy which play important roles in thermodynamics, are defined. Most students are familiar with the term *temperature* and have little difficulty in understanding its meaning. However, the term *entropy* is rather different. Although most of the students who have learned some thermodynamics

may be familiar with the term entropy, many of them have only a vague idea of the physical meaning of entropy.

This is because macroscopic thermodynamics cannot give a clear answer to this question, which can be answered only from a microscopic point of view. Therefore, a microscopic interpretation of entropy is given in Chapter 3 which, hopefully, will help the students understand the physical meaning of entropy. Chapter 4 considers the applications of the combined first and second laws.

Several thermodynamic potentials, which are important in the understanding of the equilibrium condition of a thermodynamic system under different external constraints are introduced and defined in Chapter 5. Chapter 6 introduces methods of cooling and the third law. The conditions for phase equilibrium are studied in Chapter 7, including the coexistence condition for the different phases of single-component matter and the various phase diagrams for a binary mixture. Some applications of thermodynamics are given in Chapter 8. These include the application of thermodynamic relations to non-PVT systems, such as a magnetic system, a surface (thin film) system, and blackbody radiation. Chapter 9 presents the kinetic theoryof gases, in which a gas is considered to be composed of molecules, and classical collision theory is used to study the properties of a dilute gas. These include *non-equilibrium* transport processes. The kinetic theory of gases is a microscopic theory, however this approach cannot be extended to study more condensed matter, such as liquids and solids. Statistical theory is needed to study these more complicated systems.

Chapter 10 studies the basic principles of statistical thermodynamics. Three different kinds of statistics for particles are introduced and their distribution functions are derived. The important elements of statistical mechanics, the concept of an ensemble and the partition function are also introduced. Chapter 11 studies several simple systems whose partition functions are relatively easy to obtain, so their thermodynamic properties can be studied. In this chapter, the properties of ideal quantum gases, including a Fermi and a Bose gas, near the temperature of absolute zero are studied.

This book is intended to be a textbook for a one-semester course. However, it is not quite possible to cover all the material in one semester. Some choices of the topics may be necessary. The following provides suggestions for two possible choices:

(1) If the course emphasizes macroscopic thermodynamics, then Chapters 9–11 may be omitted. Chapter 8 is optional, however, Sections 8.2 and 8.8 are recommended.

(2) If the course emphasizes microscopic statistical thermodynamics, then Chapter 4, Sections 7.6–7.14, and Chapter 8 may be omitted, however, Sections 8.2 and 8.8 are recommended.

Solving problems is an important part of studying any subject in physics. It is recommended that the students would do all, or at least, most of the problems given at the end of each chapter.

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