Preface

According to an anecdote, the German physicist Arnold Sommerfeld said the following in the 1940s: “Thermodynamics is a funny subject. The first time you go through it, you don’t understand it at all. The second time you go through it, you think you understand it, except for one or two small points. The third time you go through it, you know you don’t understand it, but by that time you are so used to it, it doesn’t bother you any more.”

Things have changed much since then. University education has become available for a large number of students, and the Bologna process has led to a three-tier system also in the European Higher Education Area. As a result, most of the students of natural sciences or engineering do not have the opportunity any more to study subjects such as thermodynamics over and over again in order to gain deeper knowledge. Fortunately enough, in the second half of the twentieth century a new approach for teaching the foundations of thermodynamics emerged. This postulatory approach does not lead the student through a tedious historical development of the subject, but rather introduces thermodynamics by stating four concise postulates. These postulates facilitate the understanding of the subject by developing an abstract mathematical foundation from the beginning. This however rewards the student with an easy understanding of the subject, and the postulates are directly applicable to the solving of actual thermodynamic problems.

This book follows the postulatory approach used by Herbert B. Callen in a textbook first published in 1960. The basics of thermodynamics are described as briefly as possible whilst ensuring that students with a minimal skill of calculus can also understand the principles, by explaining all mathematical manipulations in enough detail. Subsequent chapters concerning chemical applications always refer to a solid mathematical basis derived from the postulates. The concise and easy-to-follow structure has been maintained – also in the chapters on applications for chemically important topics.

Though the text has been written primarily for undergraduate students in chemistry, I also kept in mind the needs of students studying physics, material sciences and biochemistry, who can also find a detailed introduction to the chemical aspects of thermodynamics concerning multi-component systems useful. The book has been intended to cover a considerably wide range of topics, enough for a chemistry major course. However, some sections can be considered as optional and may be omitted even during a standard physical chemistry course. Examples are the fundamental equation of the ideal van der Waals fluid (Sect. 2.2.6), the equations of state of real gases, fluids and solids (Sect. 4.5), practical usage of engines and refrigerators (Sect. 5.4), or multi-component phase diagrams (Sect. 7.7). These omitted parts however can also be useful as a reference for the student during further studies in more specific branches of physical chemistry. The material covered in the appendix serves mostly to provide technical help in calculus, but it also contains a treatise of the "classical" laws of thermodynamics. It is important to be familiar with this aspect of thermodynamics to understand classical texts and applications that make reference to these laws. As this material is not necessary to understand postulatory thermodynamics, it is best left in the appendix. However, it is highly advisable to include it in the course material. Though the chapter on statistical thermodynamics could be skipped without any consequence to understanding the rest of the book, it is also advised to include it in a standard course. Quantum chemistry along with statistical thermodynamics is essential to help the student develop a solid knowledge of chemistry at the molecular level, which is necessary to understand chemistry in the twenty-first century.

This material is a result of 4 years of teaching thermodynamics as part of the new undergraduate chemistry curriculum introduced as the first cycle of the three-tier Bologna system. It has been continually improved through experience gained from teaching students in subsequent semesters. A number of students who studied from the first versions contributed to this improvement. I would like to mention two of them here; Tibor Nagy who helped to rectify the introductory chapters, and Soma Vesztergom who helped a great deal in creating end-of-chapter problems. I am also indebted to colleagues who helped to improve the text. Thanks are due to Professor József Cserti and Tamás Tél for a critical reading of the introductory chapters and phase transitions. Professor Róbert Schiller helped to keep the chapter on the extension of interactions concise but informative.

Since the time I first presented the text to Springer, I have experienced the constant support of Ms. Elizabeth Hawkins, editor in chemistry. I would like to thank her for her patience and cooperation which helped me to produce the manuscript on time and in a suitable format for printing.

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