

Preface

A great thermodynamicist once said that thermodynamics is not only a cornerstone of science to which all experimental results and theoretical models must conform but, due to its generality, is a framework for scientific thought. A textbook on thermodynamics is thus about teaching how to think thermodynamically. It must be rigorous and concise. It is therefore not surprising that great scientists such as Helmholtz, Planck, Sommerfeld, and Gibbs (to name a few) have produced textbooks, not just monographs, on thermodynamics. Later generations found these books too condensed and “dry” which, by the way, is not the case at all; in Sommerfeld’s book on thermodynamics, for instance, there are some very amusing personal recollections that authors of modern books would not dare to include. Still, a new generation of textbooks arrived. We want to mention two, namely the volume by Landau and Lifshitz on Statistical Physics and the book “Theorie der Wärme” by Richard Becker. Both are brilliant and represent new views and insights. As one of us (HJK) learned thermodynamics largely from these two books it will not be surprising to find a certain continuity. After all, every generation of scientist starts on the shoulders of giants! More recent books are to a large extent (with exceptions of course) simplified versions of this material to the point where the logical structure and simplicity of thermodynamics are lost among a forest of simple examples and, what is abhorrent, simplified derivations and explanations to the point where they are inconsistent and misleading. Thus to a student of these books, thermodynamics appears to be a series of unrelated tricks designed to get particular results.

Our aim in writing this textbook can be summarized as follows:

- The presentation of thermodynamics should be concise and rigorous.

- No subject or topic should be introduced as “well known” but succinctly and precisely.
- No step in a derivation should be labeled “obvious”.
- Because the pioneers of thermodynamics were frequently “amateurs” and had very colorful careers, brief historical remarks will be presented including amusing anecdotes and pictures.
- As environmental concerns must at least in part be addressed by thermodynamic methods, we will frequently lean towards those concerns for examples, such as investigating the thermodynamics of hurricanes.
- We address other topics not typically found in undergraduate textbooks, such as thermodynamics of surfaces and polymers.

The material presented in this book has been used by one of us (HJK) for many years in a one-semester course given at the second, third, or fourth year level. The prerequisites are consequently minimal: a working knowledge of functions of many variables and partial derivatives; a primer on the necessary mathematics is given as an Appendix. Concepts and facts from first and second year physics classes should also be familiar.

At this point, we would like to mention that the two authors have approached the creation of this text from essentially opposite ends of their academic careers. HJK is a senior scientist who has taught the subject for a number of years. Conversely, IT (once a student of HJK) has only recently completed his formal academic training. This collaboration has resulted in a unique view on the topic: one that has the breadth of experience that can only be earned with time, yet is still very connected and aware of the perspective (and limitations) of a student new to the field. We have therefore focused on producing a narrative that pays careful attention to address both the conceptual and technical hurdles that students typically face. Furthermore, we have arranged the material in a manner consistent with how it is best communicated in a classroom.

Important concepts are addressed more than once. We first introduce the essence of an argument and in subsequent discussion it is refined and analyzed. This ensures that details of an argument, while crucial for a complete understanding, are not so overwhelming that key physics cannot be distilled. This approach is in keeping with the spirit in which thermodynamics was constructed. As the reader shall see, this was not a theory that was written down by one individual at one particular time. Like students facing a new subject, it was struggled with over time.

Our aim and hope for this endeavour will be achieved if the students gain a working knowledge of thermodynamics, and if ultimately they appreciate the intellectual beauty of thermodynamics as expressed in the quotes by Einstein and Eddington.

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