Thermal Physics

Energy and Entropy

Written by distinguished physics educator David Goodstein, this fresh introduction to thermodynamics, statistical mechanics and the study of matter is ideal for undergraduate courses.

The textbook looks at the behavior of thermodynamic variables and examines partial derivatives – the essential language of thermodynamics. It also explores states of matter and the phase transitions between them, the ideal gas equation and the behavior of the atmosphere. The origin and meaning of the laws of thermodynamics are then discussed, together with Carnot engines and refrigerators and the notion of reversibility. Later chapters cover the partition function, the density of states and energy functions, as well as more advanced topics such as the interactions between particles and equations for the states of gases of varying densities.

Favoring intuitive and qualitative descriptions over exhaustive mathematical derivations, the textbook uses numerous problems and worked examples to help readers get to grips with the subject.

DAVID GOODSTEIN is the Frank J. Gilloon Distinguished Teaching and Service Professor Emeritus at the California Institute of Technology. He has extensive research experience in condensed matter physics, and his book *States of Matter* (Prentice Hall, 1975) was hailed as launching this important field. He directed and hosted the popular television series The Mechanical Universe, which was based on his lectures at Caltech.

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Preface

This is a book for students who have some familiarity with general physics and the calculus to learn what thermodynamics and statistical mechanics is all about, starting with the fact that you don't have to know what a system is doing, just how many things it could be doing, to get precise values of its thermodynamic variables, particularly its temperature and pressure. That insight is discussed and explained in the first chapter, along with some simple observations about the peculiar behavior of very large numbers. It uses the perfect gas to illustrate its points.

Chapter 2 looks into the behavior of thermodynamic variables and gives a lesson in partial derivatives, the essential language of thermodynamics. It also considers the various ways of expanding an ideal gas. Chapter 3 deals with the states of matter and the phase transitions between them, and also covers temperature scales, the ideal gas equation of state and the behavior of the atmosphere.

Chapter 4 considers the origin and meaning of the first and second laws of thermodynamics and goes on to discuss Carnot engines and refrigerators and the notion of reversibility. Chapter 5 addresses the probability of finding a system in a particular state and goes on to deal with the partition function and the density of states.

Chapter 6 concerns itself with the various energy functions and includes a neat mnemonic device for remembering them all. Chapter 7 deals with statistical mechanics for fixed and variable N and the grand partition function. Chapter 8 treats some more advanced topics, particularly interactions among the particles and equations of state of gases of varying densities.

The book is designed to offer a good rigorous introduction to thermodynamics, statistical mechanics and the study of matter in general.

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