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Statistical Thermodynamics sets out to provide the basic groundwork that will lead 3rd and 4th year undergraduate students of chemistry and chemical engineering from their existing knowledge of elementary classical thermodynamics to an understanding of the predictable statistical behaviour of assemblies of large numbers of identical molecules, in an ideal gas at constant temperature and volume. It begins by establishing the basis of the Boltzmann distribution law and proceeds, through definition of the molecular partition function, to link the laws of thermodynamics (which avoid any mention of atomic or quantum theory) to the statistical behaviour of assemblies of quantum particles. Equations are derived that relate thermodynamic state functions to the molecular partition function and these form a basic tool kit with which to tackle problems from a knowledge only of the relative populations of quantum energy states. The various contributions to the partition function (translation, rotation, vibration, electronic) are explored and derived. The book ends with a chapter in which all the concepts are brought together in the calculation of equilibrium constants for reactions between ideal gases. A number of fully worked examples are included, making this an invaluable aid to undergraduate chemistry, physics, chemical engineering and materials science courses. Postgraduate biochemists and molecular biologists will also find this book useful.