# Steps up for the student

*John Tilley*

**Statistical Physics.** By Tony Guénault. *Routledge: 1988. Pp.186. Pbk £5.95, $17.95.*
**Statistical Physics, 2nd edn.** By F. Mandl. *Wiley: 1988. Pp.385. Hbk £44, $88; pbk £11.95, $23.90.*
**Statistical Mechanics.** By B.K. Agarwal and Melvin Eisner. *Wiley Eastern: 1988. Pp.270. £26.95, $39.95.*

It is surely not just folklore that generations of physics students have found statistical mechanics to be one of the hardest parts of their subject to grasp at first meeting. Some of the difficulties originated from the custom of following the historical sequence by teaching classical statistical mechanics (phase space, Liouville's theorem and so on) before the quantum version. However as Guénault clearly demonstrates in his short text, it is simpler to base an introduction on ideas from quantum mechanics such as energy levels, single-particle quantum states and degeneracy. Teachers will find here a persuasive argument in favour of the quantum approach preceding the classical.

The author's goal is to show fairly quickly what statistical mechanics can do in a wide variety of applications, without dwelling upon its theoretical foundations. The Boltzmann distribution is derived first, then the three ideal-gas distribution functions by the method of grouping single-particle states of almost identical energy. The applications include adiabatic demagnetization, black-body radiation, liquid $^3$He and liquid $^4$He, and ferromagnetism. Students will be attracted by the informal, almost racy style. Anyone who masters this text and copes with the well-chosen illustrative problems will have learned much important physics, and will be equipped to tackle a deeper and more mathematically sophisticated treatment of the field. It seems a pity, therefore, that there is no bibliography to point the reader onward to more advanced texts.

Judging by the introductory textbooks that have been published in the past 20 years or so, there is a growing tendency to treat thermal physics as an entity instead of dealing with thermodynamics and statistical mechanics separately. Mandl's text, first issued in 1971 and now revised, is of that genre. One justification for the unified approach, manifest in this carefully structured account, is that it enables the presentation of statistical mechanics as the bridge between the microscopic quantum view of matter and the macroscopic description used by thermodynamics. It is also an obvious way to show how each topic illuminates the other, examples being the quantum definition of entropy and the link between the partition function and the free energy.

Mandl's book is more demanding of the reader than Guénault's: there is more emphasis on fundamentals and a wider selection of theoretical concepts. For instance, the Gibbs distribution is stressed, and its advantage over the grouping-of-states method in obtaining the Fermi–Dirac and Bose–Einstein distribution functions is clearly shown. The author includes several important applications, some as subjects for the challenging problems at the end of each chapter. The section containing hints for solving the problems is a valuable feature.

More advanced still, the text by Agarwal and Eisner is aimed at the advanced undergraduate and postgraduate. It is certainly not a book for beginners, although it has the virtue of setting out involved mathematical arguments in full detail. The first chapter is devoted to classical statistical mechanics, and the rest then follows a straightforward exposition of Gibbs's ensemble theory. Problems usefully fill out the material of each chapter. There are brief mentions of topics of current interest, such as the quantum Hall effect and the renormalization group theory of phase transitions. However, this book (which is rather unattractively produced) faces strong opposition in the form of established works such as Huang's *Statistical Mechanics* (Wiley) or *Statistical Physics* in the Landau and Lifshitz series (Pergamon). □

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# Course variety

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**Fundamentals of Solid State Physics.** By J. Richard Christman. *Wiley:1988. Pp.518. Hbk £41.55, $46.85; pbk £13.95, $12.85.*
**Basic Solid State Chemistry.** By Anthony R. West. *Wiley:1988. Pp.415. Hbk £50, $97.75; pbk £13.50, $26.40.*
**Lectures on the Electrical Properties of Materials, 4th edn.** By L. Solymar and D. Walsh. *Oxford University Press:1988. Pp. 465. Hbk £35, $55; pbk £15, $27.50.*
**Electrons in Solids: An Introductory Survey, 2nd edn.** By R. H. Bube. *Academic:1988. Pp.315. £27.50, $39.50.*
**An Introduction to Solid State Diffusion.** By Richard J. Borg and G.J. Dienes. *Academic:1988. Pp.360. £33, $49.50.*

We now know a lot about the solid state: what aspects of that knowledge should be covered in an undergraduate course?

Many elements and compounds can be fabricated in a variety of solid forms, and have diverse mechanical, thermal, electrical, optical, magnetic and chemical properties. The basic science of these properties is relevant to all materials — from steel to concrete, from plastics to carbon fibres, from micro-electronics to optical components. How then does one construct the syllabus for what is just one component in an undergraduate course in chemistry or in physics? How should one treat the topics that will be needed by students of materials science or electrical engineering who have not had the background courses in physics or chemistry?

J. Richard Christman claims that his book, *Fundamentals of Solid State Physics*, is an appropriate text for a "first course in solid state physics at the advanced undergraduate level". It covers most of what it has been customary to teach physics undergraduates, plus a bit more. The emphasis is therefore on lattice vibrations and the band theory of electrons, preceded by crystal structure and bonding, and leading on to optical and magnetic properties. There is the usual section on superconductivity and an introduction to semiconductor devices, in which the author discusses the p–n junction and touches on some forms of transistor. As is rather common in physics courses, properties which depend on crystal anisotropy and on lattice defects receive only token attention; the page on dislocations is inadequate and misleading.

The book is a genuine contender in the market that has largely been monopolized for a generation by successive editions of Charles Kittel's *Introduction to Solid State Physics*, but I would admire the student who could successfully use it in a first course on the subject. The students I teach tend to need an intermediate step between basic physics and the solid state at the advanced undergraduate level.

A chemist's view is provided by Anthony R. West in *Basic Solid State Chemistry*. As one would expect, West puts more emphasis on structure and bonding, and there is discussion of a much wider range of materials, including the newly discovered high-$T_c$ superconductors. Some crystallography is covered, with simple ideas being developed quite a long way, although the reciprocal lattice is not mentioned. The reader is introduced to phase diagrams, to