examples of simple solutions, was the typical pattern. The "apology" in Starling comes in the preface, where he says, "No apology is offered for using the methods of the differential and integral calculus whenever it appeared that an advantage was gained by so doing, since it is imperative that a student who wishes to pursue his studies in electricity must have so much (sic) mathematical equipment."

Perhaps the next stage is exemplified by Jeans' *Electricity and Magnetism*, or Smythe's *Static and Dynamic Electricity*. By now the techniques of measurement have become too well known (?) to merit much attention and the majority of the text is taken up with a detailed discussion of the various techniques of solving particular problems, special cases of the basic theory.

By the time of the third stage, these details, the calculation of specific electrostatic problems, of radiation from various kinds of antennas and of particular examples of microwave propagation, have been, for the most part, relegated to engineering texts. The mathematical notation has been streamlined so that the general equations appear simple and the emphasis is put on connecting electromagnetic theory to the broad principles underlying all physics, to the conservation laws, to thermodynamics, and to relativity, for example.

Judging from the developments in texts on classical dynamics since Mach, there may be a fourth stage, perhaps not yet reached in electromagnetic theory. In this stage, the theory enters the realm of applied mathematics and texts are written in the deductive manner, with axioms and propositions and carefully proved theorems.

The text of Panofsky and Phillips is a good example of the third stage of textual development. Techniques of solution are discussed, but the emphasis is on general principles rather than individual algorithms. There is no discussion of measurements; the first chapter is on the mathematical properties of vector fields and is followed by an excellent, though brief, discussion of the relation between *E*, *D*, and the polarization of a dielectric. After two chapters on two- and three-dimensional static problems, enough to show the general procedures, there is a clear discussion of the stress-energy tensor and its relation to volume forces and the free energy of a dielectric.

After two chapters on steady-state magnetic fields, we are already to Maxwell's equations, with two-thirds of the book yet to come. Wave solutions take up only three more chapters, however, plus a chapter on energy, force and momentum relations; the rest of the book is concerned with the connection between electromagnetic theory and special relativity. Here, interestingly enough, experimental details take up a compact and well-organized chapter, relativity still seems to need a résumé of its experimental justification.

After several chapters on the Lorentz transformation and the momentum, force and potential four-vectors, there is a clearly-written discussion of the field around a point charge, with and without acceleration, the radiation reaction on an electron and the related expressions for the scattering of radiation from an electron. The final chapters discuss briefly the energy-momentum tensor in material media in its covariant form and the Hamiltonian formulation of Maxwell's equations.

This is obviously not a text to train technicians to design microwave hardware. It can, however, be used to show beginning graduate students the scope of classical electromagnetic theory and how it fits into the rest of physics. And it can prepare them for the additional intricacies of quantum field theory. As such it should be most welcome. Its choice of material and order of presentation should make it rather more satisfactory as a text than Landau and Lifshitz', *Classical Theory of Fields*, which covers somewhat the same ground.

There are a few exercises, of graduated difficulty, at the end of each chapter, an appendix on units, a number of tables of vector formulas, and a short but adequate index. The reviewer, of course, has no fault to find with the bibliographic notes at the end of each chapter.

**Crystal Physics 1.** Vol. 7, Part 1 of Handbuch der Physik. Edited by S. Flügge. 687 pp. Springer-Verlag, Berlin, Germany, 1955. \$29.15 (Subscription price if part of the series, \$23.32). *Reviewed by H. P. R. Frederikse, National Bureau of Standards.*

*Crystal Physics I* is the first volume to appear of a new *Handbuch der Physik*, successor to the well-known *Handbuch of Geiger and Scheel*, now more than 25 years old. This new work will cover the field of physics in 54 volumes, to be published in the next three or four years. The editor, S. Flügge, has realized that such an enterprise should be on an international basis; more than 200 experts in the different fields of physics from all over the world will contribute to this work. The articles will appear in German, English, and French.

The present volume includes four articles: Crystallography, by H. Jagodzinski; Theory of the Mechanical and Thermal Properties of Crystal Lattices, by G. Leibfried; Theory of Lattice Imperfections, by A. Seeger (all three in German); and Specific Heat of Solids, by M. Blackman (in English).

The authors have succeeded in giving a rather complete and up-to-date review of the present-day knowledge in these four fields of solid state physics.

The article on Crystallography treats in detail the symmetry operations, crystal classes, space groups and considers the fundamental relations between physical properties of solids and crystal symmetry. The latter part of this review article is devoted to crystal geometry and the lattice structures of elements and compounds.

Leibfried's contribution is concerned with the theory of the lattice in equilibrium (binding energy) and the mechanics of small displacements (elastic constants) and thermal vibrations (specific heat, heat conductivity). One notices that the author has deliberately limited his treatment of the specific heat and the thermal

conductivity in view of the fact that these topics are discussed in detail elsewhere in the *Handbuch*. The close interrelation between different fields of physics makes it, of course, impossible to completely avoid any overlap in an encyclopedia of this size.

In the third article Blackman gives a comparatively short, but well-balanced, survey of the specific heat of crystals. Throughout the review Debye's theory plays a dominant role. It is interesting to notice that, though much better calculations of specific heats, derived from detailed vibrational spectra, are now available, the results are nearly always discussed in terms of deviations from the Debye curve.

The last article gives a comprehensive survey of the theory of lattice imperfections (Schottky and Frenkel defects, dislocations, etc.). The author states in the introduction that hardly any mention will be made of those imperfections which are mainly characterized by their electronic excitation; such centers will be treated in later volumes. In spite of this limitation, it is impossible to describe in a few words the enormous wealth of information and theoretical analysis contained in this article.

A double subject index (English-German and German-English) assists the reader considerably in finding his way in this important reference work.

**Ionized Gases.** By A. von Engel. 281 pp. Oxford U. Press, New York, 1955. $6.75. *Reviewed by S. F. Singer, University of Maryland.*

Ionization and excitation phenomena in gases have become important in atomic physics, astrophysics, spectroscopy, and the physics of the atmosphere and of the solid state, but they do not generally form part of the undergraduate physics curriculum. Perhaps the present volume will change this trend. It is not to be compared to the earlier two-volume work by von Engel and Steenbeck; it is written on a much simpler level with a more limited choice of topics. The book stresses the fundamentals of ionization and excitation processes in gases, collision phenomena, and recombination, with only a small fraction devoted to glow and arc discharges. What makes the book especially valuable, also to research workers, are the many numerical tables of important physical parameters in gas discharges, and the many clear diagrams (144 of them), plus the many references.

**Low Temperature Physics** (4th Edition). By L. C. Jackson. 158 pp. (Methuen, London) John Wiley & Sons, Inc., New York, 1956. $2.00. *Reviewed by E. A. Lynton, Rutgers University.*

The expansion of the areas of investigation and the techniques of low-temperature physics during the past decade has brought about not only a correspondingly large increase in interest in this field, but also rapid obsolescence of most general books on the subject. What a pleasure, therefore, to welcome a largely re-