of the enzymes and macromolecules above the molecular level into subcellular particles (chapters 3 and 4). In the next chapters attention is directed to the problems of finding out how molecular events underlie macroscopic phenomena, with special reference to the modes of action of vitamins, drugs, and genetic factors. The simple diagrams are accompanied by copious notes, in smaller print, which describe the transformations in more detail, but in the same clear and easy style. Chapters 5, 8, and 9 seem to be out of place in the text. If chapter 5, "Two approaches to biological explanation—analogy and analysis," followed chapter 1, "Biochemistry in relation to biology and chemistry," and chapters 8 and 9, "A common currency for energy transactions—ATP" and "Transmitting information—biochemical genetics," were placed immediately after chapter 4, "Organization and efficiency —subcellular particles and biological oxidations," the arrangement would be more coherent.

I can recommend this book very highly, not only to the uninitiated but also to more experienced biochemists. It should also be in the science libraries of high schools.

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Soil Properties

Soil Clay Mineralogy. A symposium held at Blacksburg, Virginia, in July 1962. C. I. Rich and G. W. Kunze, Eds. University of North Carolina Press, Chapel Hill, 1964. xvi + 330 pp. Illus. $8.

A seminar on soil clay mineralogy, sponsored by the Southern Regional Cooperative Research Project S-14 on Soil Properties, was held at the Virginia Polytechnic Institute in July 1962. Nine authorities on clay mineralogy were invited to give lectures in their specialties, and the stated object of this volume is to present condensed versions of these lectures "to the scientific community at large, particularly to all those working with clay mineralogy regardless of their ultimate interest in this subject."

Unlike papers in the series *Clays and Clay Minerals* (the proceedings of the National Clay Conferences, now the Clay Minerals Society), the chapters in this volume are not technical presentations of new data, nor do they form a textbook of elementary clay mineralogy. The contributions are aimed at an audience that is already familiar with the rudiments of clay mineral structure, chemistry, and nomenclature, and, with two principal exceptions, they are mainly reviews of the state of the art in each of several methods used to analyze clay minerals. The first exception is the first and longest chapter (73 pp.), a discussion by W. D. Keller (University of Missouri) of the physical-chemical factors involved in origin and alteration of clay minerals. The strong geologic orientation of this chapter emphasizes the fact that the material in this book is applicable to other disciplines as well as soil science.

The chapter "Structure and mineral analysis of soils," by Roy Brewer (Commonwealth Scientific and Industrial Research Organization, Canberra, Australia), is in textbook form and treats the classification of soil structures, definitions of soil structure terms, and illustrations of soil structure features. In the section on mineral analysis, Brewer is concerned with the factors to be considered in analysis rather than with the description of analytical techniques.

The short (11 pp.) chapter on x-ray diffraction analysis, by W. F. Bradley (University of Texas), appears to be a considerably condensed version of his lecture; owing to its somewhat formidable, though accurate, language this chapter will probably be useful only to readers who are already familiar with the physics of x-ray diffraction. However, it is supplemented by a discussion of x-ray methods and interpretation in the chapter by M. L. Jackson (University of Wisconsin) on mineralogical analysis.

In the chapter on application of the electron microscope, Thomas F. Bates (Pennsylvania State University) presents illustrations of distinguishing features of clay minerals and discusses factors that affect their appearance in electron micrographs. Preparation techniques for electron microscopy are detailed in the chapter by John L. Brown (Georgia Institute of Technology).

Three chapters concern the history, theory of operation, and application to clay mineralogy of particular analytical tools—infrared analysis by R. J. P. Lyon (Stanford Research Institute); thermal analysis by R. C. Mackenzie (Macaulay Institute for Soil Research, Aberdeen, Scotland); and x-ray spectrographic analysis by A. H. Beavers and Robert L. Jones (University of Illinois).

In the final chapter, M. L. Jackson and R. C. Mackenzie discuss the principles of quantitative estimation of clay minerals from standard chemical analyses. This chapter, together with Jackson's chapter on mineralogical analysis, contains what appears to be as complete a catalog, in brief, of the many varied and often quoted analytical methods used by Jackson and his co-workers as any previous publication of which I am aware. Not every reader will wish to follow all the procedures in this book, but the procedures illustrate well what may be involved in a highly detailed analysis of a clay-bearing sample.

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Modern Geometric Optics

Mathematical Theory of Optics. R. K. Luneburg. With a foreword by Emile Wolf and supplementary notes by M. Herzberger. University of California Press, Berkeley, 1964. xxx + 448 pp. Illus. $12.50.

This book by the late R. K. Luneburg is based on the lecture notes that he used at Brown University during the summer of 1944. Those notes have long been regarded as an original and, in fact, classical treatment of modern geometric optics. We are fortunate to now have the same material made more readily available in the form of a book, for which Emile Wolf has written a foreword.

In chapter 1, it is shown how the two main avenues of optics, wave optics and geometric optics, can both be developed from Maxwell's equations. In chapter 2, Hamilton's theory of geometric optics is formulated, and, in chapter 3, some of its applications are outlined. These include complex lens systems, aspherical surfaces, media of radially symmetrical refractive index, spherical aberration and coma, and the "Luneburg lens." A lens of this type images two spherical surfaces stigmat-

ically on each other, a principle that has been used for microwave antennas.

Chapter 4 is concerned with first order optics, and chapter 5 with third order aberrations in systems of rotational symmetry. In chapter 6, we find a discussion of the diffraction theory of optical instruments. Two appendices deal with vector analysis and ray tracing; and four supplementary notes, the last three written by M. Herzberger, contain discussions on electron optics, optical qualities of glass, mathematics and geometrical optics, and the symmetry and asymmetry in optical images.

It is chapter 6 about which I have some more general reservations. In any highly analytical treatment of a topic in physics it is easy to elucidate mathematical complexities for their own sake rather than to consider them in their supporting role. Rayleigh's (not Raleigh's) criterion, for example, no longer occupies the central position that one is made to believe, especially not since the advent of transfer functions. Periodic structures, likewise, do not deserve such detailed treatment unless, of course, the treatment leads to a discussion of the intriguing possibilities of, under certain conditions, exceeding the classical "limits of resolution."

Still, I do not hesitate to call Luneburg's book, after perhaps the texts by Born and Wolf and by Sommerfeld, one of the outstanding advanced treatments of modern optics, at least of certain aspects of modern optics.

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Analytical Chemistry

Handbook of Industrial Infrared Analysis. Robert G. White. Plenum Press, New York, 1964. xiv + 440 pp. Illus. $19.50.

White's *Handbook of Industrial Infrared Analysis* consists of seven chapters: "History, theory, and terminology," "Instrumentation," "Techniques," "Qualitative analysis," "Quantitative analysis," "Applications," and "Literature."

In chapter 1, which is very brief, the author has deliberately minimized the theory of infrared spectroscopy for the benefit of the nonprofessional spectroscopist. Therefore, some of his theoretical explanation is unclear. For example, after briefly describing fundamental vibrations he states that "other internal motions in the molecule are combinations or overtones of such fundamentals." However, for those interested in this aspect of the subject, he has referred to some well-known texts on infrared (IR) theory. In my opinion, those seriously interested in using IR for anything other than the most routine investigations (for example, quality control and routine analytical analysis) will need a more detailed theoretical development.

Chapter 2 is useful, for in it the author has presented the salient features of commercially available infrared spectrometers; this information should help purchasers to select the instrument best suited for their particular requirements. Wavelength calibration and performance evaluation of spectrometers are included.

The high point of White's handbook is his thorough discussion of the many methods and techniques used to obtain infrared spectra of chemical compounds (chapter 3). White appears to have strong preferences for the use of the KBr technique. Also included, and by no means unimportant to the spectroscopist, are the physical hazards of the solvents commonly used in the IR laboratory. However, he fails to mention that many of the chemicals submitted for IR analysis can be as hazardous as or more hazardous than the solvents used to obtain their solution spectra.

Qualitative interpretation of IR spectra is dealt with in chapter 4. This chapter follows closely the spectra-structure correlations covered in Bellamy's book, which White cites frequently. White's treatment leaves me with the impression that most identifications of chemical compounds performed by the industrial IR spectroscopist are of compounds already characterized by other means; he seems to imply that all one has to do is obtain an IR spectrum of a particular substance, spot a few characteristic group frequencies, or the absence thereof, and, by the use of some sort of searching technique of standard spectra, all will be identified. But much of industrial IR spectroscopy is concerned with establishing or verifying structures of hopefully new and patentable organic compounds. The author mentions the competition of other physical methods with IR. The word "competition" should be replaced by "coordination" (preferably with the cooperation of those experts who use other physical methods of analysis—nuclear magnetic resonance, mass spectrometry, x-ray, Raman spectroscopy, and the like). Integration of these physical methods can only strengthen the final conclusion. Although White and I both believe that IR is the most versatile tool for structural analysis, one must realize that the method has some limitations.

Chapter 5, on quantitative analysis, is quite instructive for those who wish to learn to do this type of work properly. Chapter 6 covers much of the published work on the application of IR to the solution of chemical problems. The last chapter, although short, contains a wealth of information on the literature of the field.

White's handbook contains much information not readily available elsewhere, and most laboratories, including those in the universities, will find in it something of value. It is also recommended to those in the chemical profession who are not familiar with the ways in which the use of IR might be helpful to them.

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Introductory Volumes

Isotopes in Biology. George Wolf. Academic Press, New York, 1964. x + 173 pp. Illus. Paper, $2.45; cloth, $5.50.

A Tracer Experiment: Tracing Biochemical Reactions with Radioisotopes. Martin D. Kamen. Holt, Rinehart, and Winston, New York, 1964. 127 pp. Illus. Paper, $1.28; cloth, $2.50.

The first of these two short paperbacks, *Isotopes in Biology* by George Wolf, is an elementary and necessarily superficial introduction to the use of both stable and radioactive isotopes as tracers in biological systems. The presentation is designed for beginning and graduate students in biology as well as for scientists who wish to use the technique but have had no previous experience with it. The author begins with a brief discussion of the physics and chemistry of isotopes, units, and hazards. Some of the potential pitfalls in