One popular philosophy says that universities ought to be the agents which transmit higher learning from one generation to the next. This "model" does reasonably well in some of the so-called pure sciences, does less well in engineering, does rather poorly in the social sciences, and is hopelessly bad in the "humane" areas of learning. If universities are engaged in expanding and deepening the student's intellectual powers, they must do so with serious regard for the way in which the intellectual powers are related to other aspects of personal and social life. This wordy description is captured by the dissident students in the word "relevance." If a person's whole life is a monastic devotion to a science, then the relevant growth of his intellect may be quite clear. But otherwise it is by no means evident or simple to decide what intellectual changes ought to occur. At one time, we believed it was Latin that should above all be transmitted; now many think it is mathematics and computer sciences. What many of the dissident students are saying is that the intellectual life and the political life are aspects of the same being. From this point of view, the increase in campus rules governing political activity is a disaster, because as all of us know one does not learn by rigid regulations.

Ridgeway's conclusion is a hope that "the country will pursue the idea that a university is a place where great teachers and students are brought together." My hope is that the country won't do anything of the kind. It is a blessing that there are so few great teachers on our campuses who spellbind the student with fascinating irrelevance and who have stopped learning long ago. Perhaps a far richer philosophy of higher education might emerge if we depicted the ideal university as one in which every person is both teacher and student, one in which the student and the faculty learn how to learn.

Since Ridgeway urges us to be hopeful, we might also hope to include the administrators and trustees in such a community. If I were scoring a university for its performance, I'd count as negatives the number of required courses, the number of lecture courses, the number of regulations governing student and faculty behavior. I'd count as positives the number of students actively engaged in imaginative research with faculty, the hours of open debate, the courses of open discussion. And on the agenda of debate and discussion could surely be the question of Ridgeway's book: How should faculty and administrators spend their time? But a far more serious item for the agenda should be: What is a university?

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Analysis by Reaction Rates

Kinetics in Analytical Chemistry. HARRY B. MARK, JR., and GARRY A. RECHNITZ, with the assistance of Ronald A. Greinke. Interscience (Wiley), New York, 1968. xii + 339 pp., illus. $16.95. Chemical Analysis, vol. 24.

The development of kinetic methods in analysis is, as the authors of this book state, opening up an important new area of research in analytical chemistry. Advances in instrumental technology, new methods of studying fast reactions, increased use of differential rate methods and catalytic reactions are all contributing to the development of chemical analysis by kinetics. The authors are active in this research area and are in an excellent position to bring its possibilities to the attention of chemists not acquainted with the field. The book contains some quite elementary material, such as the definition of a catalyst, explanations of the sensitivity of catalyzed reactions, and discussions of the effect of concentration and temperature on reaction rates. On the other hand, parts of the book deal with specialized topics, including the derivation of response functions for various input functions in relaxation methods and some highly detailed treatments of error analysis in differential-rate methods. The uneven level of treatment constitutes one weakness of the book. Unfortunately, it is not the only weakness.

The authors discuss both practical kinetic methods used in analysis and theoretical aspects of kinetics that are important in analysis. It is their intention to illustrate the advantages that kinetic techniques have over equilibrium techniques. After a chapter on the measurement of reaction rates they devote two chapters to kinetic methods for catalyzed and for uncatalyzed reactions. Simultaneous determinations of closely related mixtures in theory and in practice are treated. The determination of organic mixtures and correlations of reaction rate with structure are considered. A chapter written with the assistance of Louis J. Papa gives a general error analysis and a detailed evaluation of three methods of handling differential rates for the simultaneous determination of compounds. The book closes with a chapter on analytical reactions from the kinetic viewpoint.

The conceptual plan for the book—from its opening remarks concerning advances in instrumental technology to its closing attempt to display the usefulness of kinetic information in analytical chemistry—is a good one, but in execution it is disappointing despite the fact that many topics of interest are included. The authors do not give any information about instrumental advances with the exception of one or two pages in chapter 2 which are incorrect; their statements that the most widely used fast-mixing method is *continuous-flow* and that *stopped-flow* has a minimum half-life of 1 second are serious errors. Figure 1 in this chapter also is highly misleading in its implication that the appearance of products formed in a reaction mixture could be followed over a range of 10^{-12} to 10^{4} seconds.

Chapters 5 and 7, on differential kinetic analysis, are thorough and contain important information on the limitations of concentration ratios and of rate-constant ratios. However, the presentation is primarily concerned with single-point or double-point methods. In this regard the authors have honestly reflected what this reviewer thinks has been an extreme overemphasis on these methods in the literature for the past ten years. With advances in automatic rate systems and in data-acquisition systems and with the availability of computers a far more important question is how to minimize errors in calculations where there are many more points than unknowns. In practice it is hard to understand why any analyst would settle for one or two data points in a kinetic analysis unless it was an absolute necessity.

Finally, the long section on analytical reactions from the kinetic viewpoint has too much material on reactions that have little promise for analytical applications. The difficulty with this section and with much of the book is reflected in the authors' statement, "Aside from the immediate inferences of analytical significance to be derived from specific kinetic investigations, it may be possible to realize certain generalizations as a consequence of the 'kinetic viewpoint,' although at the present time, because of the lack of comprehensive data, penetrating generalizations are likely to be elusive."

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Condensed Phases

Physical Properties of Molecular Crystals, Liquids, and Glasses. A. BONDI. Wiley, New York, 1968. xxii + 502 pp., illus. $18.50. Wiley Series on the Science and Technology of Materials.

This volume, one in a series on the science and technology of materials, is a compendium of methods for estimating thermal and mechanical properties of the several states of materials indicated by the title. The motif of the work is that of Reid and Sherwood (*Properties of Gases and Liquids*), namely the use of correlations of thermal and molecular structure properties as devices for estimating other thermal and mechanical properties. Of primary interest here are compounds of relatively high molecular weight for which correlations through critical properties are not available. The author chooses methods for each class of compounds which have some basis in physicochemical principles for that class. These are briefly discussed in most sections, and the user can look to these paragraphs for insight and, more important, for pitfalls.

The primary variables used to make the correlations are, for the most part, heats of vaporization and sublimation, which are used as a measure of interaction energy and lattice energy, and van der Waals radii, which are used to include effects due to molecular size and shape. Estimates of these parameters are in turn gleaned from dipole moments on a functional group basis and from other sources. Where important, effects of barriers for internal rotations are treated, as are effects due to hydrogen bonding in liquids. The properties discussed are: heat capacity, enthalpy, entropy, thermal expansion, bulk modulus, Young's modulus, shear modulus, thermal conductivity, "rotational" diffusion, vapor pressure, critical properties, PVT properties, and viscosity. These are discussed, where relevant, under five classes of material states: crystals, crystalline polymers, liquids, polymer melts, and glasses. In addition, changes of properties on fusion and to a lesser extent other topics are discussed. These are creep compliance, sintering, mass diffusion, and mixtures. Most of the sections are concluded with "calculating procedures," step-by-step instructions, starting from the molecular structure, for estimating the property of interest. These are the most valuable attribute of the volume.

The usefulness of this volume would have been enhanced had the author been more explicit about defining and indexing symbols; chapters 3, 7, 8, 10, and 14 lack sorely needed glossaries of symbols. There are equations containing dimensionful numerical factors in which the dimensions of other factors or terms are not explicitly stated. Phrases such as "all symbols have their usual meaning" and "appropriate" (units) will irk those who have come to material science from physics or metallurgy.

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Models for the Historian

Looking at History through Mathematics. N. RASHEVSKY. M.I.T. Press, Cambridge, Mass., 1968. xviii + 199 pp., illus. $10.

In this volume, Nicholas Rashevsky "illustrates in a number of different, sometimes almost disconnected, examples how mathematical reasoning *could in principle* be used in attempted explanations of *some* historical phenomena." Trained as a mathematical biologist, Rashevsky leans heavily on biological analogies, and to a lesser extent on physical analogies, in formulating his historical models. These models are then used to explain such historical phenomena as the displacement of "religious faith" by "rational reasoning" and the diffusion of new ideas.

If Rashevsky's major purpose is to demonstrate that it is possible to mathematize history, then his volume is about a decade too late. For a large number of investigators have been working on the application of mathematical models to history since the mid-1950's. Such research has proceeded most rapidly in economic history, where scholars could draw on the large array of mathematical and statistical models produced by economic theorists and econometricians. Today, mathematical economic history, usually called "the new economic history" or "econometric history," is no longer a novelty. It is the principal way in which economic history is taught in the graduate programs of those departments which produce most of the Ph.D.'s in the field.

The mathematization of political and social history has been proceeding more slowly. In recent years two important centers have been established to promote mathematical work in these areas. One is the Committee on Mathematical and Statistical Methods in History of the Mathematical Social Science Board (MSSB). The other is the Inter-University Consortium for Political Research (ICPR). Both groups have sponsored conferences, advanced research seminars, and training institutes on the application of mathematical methods to history. MSSB is also sponsoring a volume of papers which apply mathematical methods to a wide range of problems in American and European history. One of the ICPR projects is the development of a data bank which will enable historians to relate political to demographic, social, and economic variables. In this connection they are putting on IBM cards, by counties, data drawn from each of the U.S. decennial censuses since 1790.

Since Rashevsky's volume is too late to perform the service of turning historians to a new method, the principal issue which remains is the explanatory value of the particular models he develops. Because his aim was to illustrate the possibility of formulating mathematical models of history, rather than to provide historians with models which are empirically valid, Rashevsky frequently permits himself the luxury of making assumptions in which he has little confidence. He does not deal with the problems of procuring the data needed to test his models. Indeed, he applies himself to such titanic issues, to such vast stretches of time and space, that it is unlikely that historians will ever be able to acquire the data needed to estimate the parameters of his models. This is surely the wrong direction in which to point potential builders of historical models.

Nevertheless, historians who are interested in mathematical approaches to history, and who know calculus, may find Rashevsky's book of use. Although I doubt that his models can be made operational, they may suggest other models which can.

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