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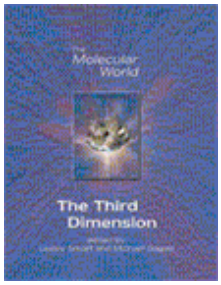
The Molecular World

*Mark A. Buntine, Geoffrey T. Crisp, Gregory F. Metha, Simon M. Pyke, Louis M. Rendina and Dennis K. Taylor**

This series of introductory chemistry texts is titled *The Molecular World* and forms part of the chemistry curriculum for the Open University in the U.K. The texts were published in 2002 in collaboration with the Royal Society of Chemistry and present the themes and concepts of organic, inorganic and physical chemistry in an integrated approach. The design and presentation of the series reflects its origins as distance education material. Each unit in the series has a similar format, so students will be familiar with the layout when progressing from one unit to the next. Each unit has a CD containing graphics, video with audio and formative tests. The series as a whole would be suitable for a course that was modular and where face-to-face teaching was not the predominant mode of delivery. This review covers four titles in *The Molecular World* series.



The Third Dimension

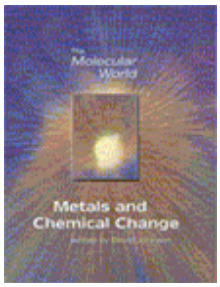
L. E. Smart and J. M. F. Gagan (Eds)

RSC, Cambridge
July 2002, 254 pp.
ISBN 0 85404 660 7
Softcover, 23.50 GBP

The Third Dimension is edited by Lesley Smart and Michael Gagan and contains many illustrative examples from the natural world and industry. This unit deals with the conceptual area of three-dimensional shape, a concept often difficult for students to visualize. It brings together aspects of stereochemistry of crystalline materials and then organic molecules, but uses only carbon containing molecules to discuss the consequences of tetrahedral symmetry. A glossary of important terms and specified learning outcomes with references to relevant parts of the text assists students in learning the vocabulary of stereochemistry. The unit as a whole is descriptive rather than an attempt to provide a detailed derivation of concepts. Where students are required to use maths assistance is given in the form of hints and basic definitions. There are questions in each chapter with detailed explanations of the answers at the back of the book. The CD is designed to be used in conjunction with the text, consistent with the distance education origin of the series. There is an interesting section on recent applications of liquid crystals at end of the text.

The text has a very readable style for introductory students and gives helpful hints with concepts students often find difficult. The various chapters are organized in a logical manner, consistent with what most chemistry teachers would expect. The book achieves its goal as a descriptive introductory text on stereochemistry whose main purpose is to familiarize students with keys concepts of molecular shape.

The two CDs are very well presented but will only run under Windows and not a Macintosh. This will limit its appeal to some students. Students are able to use the application ISIS/Draw for generating structures, and WebLab ViewerLite for manipulating three-dimensional structures. These applications can be used in conjunction with activities described in the book. Each activity has an estimated study time and students wishing to study the material at home can readily use the video sequences, with audio explanations. A set of self-assessment questions will give the correct answer after three incorrect attempts. Students may store their own scores from the assessments on their hard drive and return at a later stage to review their progress. The application keeps track of which questions have been attempted.



Metals and Chemical Change

D. A. Johnson (Ed.)

RSC, Cambridge
July 2002, 272 pp.
ISBN 0 85404 665 8
Softcover, 25.50 GBP

Metals and Chemical Change is edited by David Johnson and represents a classical approach to teaching introductory physical and inorganic chemistry. The content layout would be familiar to most teachers of courses in chemistry, but begins with a descriptive section on common metals and their oxidation, and then proceeds with the extraction of metals from their ores. Since these units were designed as distance education material, this descriptive introduction is used to present students with material from everyday life before the more quantitative content is presented.

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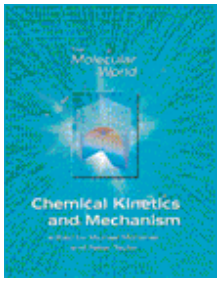
The fundamental question the book attempts to answer is why do chemical reactions occur? The key principles of thermodynamics (entropy, enthalpy, and Gibbs free energy) are then introduced in the context of the reactivity of metals. Instead of expecting students simply to memorize the activity series, the text presents a critical examination of the hypothesis that there is a tendency for metals to be oxidized in a predictable manner. Enthalpy and entropy are then introduced and the more mathematical approach to chemistry follows. The First and Second Laws of Thermodynamics are covered, and assistance with how to perform the necessary calculations is given using appropriate illustrations. The use of annotated graph paper with the corresponding calculations fully explained would be most helpful to students. The difference between kinetic and thermodynamics stability is then discussed, although it would have been better to use the less ambiguous terms 'lability' and 'stability' in the kinetic and thermodynamic sense, respectively. The text then returns to oxidation and it is discussed in terms of free energy changes, reinforcing in a quantitative manner the earlier qualitative description. Metal extraction is then revisited in terms of the associated free energy changes. Lattice energy appears after a discussion of the Born–Haber cycle, and includes a section on a more general Born–Haber cycle using thermodynamic data. The text then proceeds to electrochemical cells and redox potentials. The chemistry of the Group I and II metals is examined, including a short chapter on alkali metal anions and complexes with ligands such as the crown ethers, with a continuation in the use of thermodynamic data throughout the text. The case study at end of the unit on batteries and fuel cells would be of interest to most students.

One of the many highlights of the book is the use of everyday examples of metals and their reactivity, particularly industrial examples. A comprehensive list of learning outcomes is presented at the end of the text, and numerous questions throughout the text are linked to one or more of these outcomes. The book is illustrated with excellent diagrams and photographs including one of a 'brave' person wearing little protection sitting on a pool of mercury in order to demonstrate its high density! The text is also punctuated with interesting historical anecdotes.

The CD contains some excellent video sequences with accompanying audio explanations, such as the spectacular reactions of alkali metals with water. There are video demonstrations for laboratory experiments where students may take notes and hand in a laboratory report based on the demonstrations. This concept may become more widespread given the reduction in the resources currently available for introductory students to be able to undertake real laboratory activities! The CD also contains self-assessment modules that will store student responses on their hard drive.

Some minor quibbles about the volume (and the series as a whole) include the incompatibility of the enclosed CD-ROM with Macintosh computers, an unusual decision by the publishers considering the popularity of this platform in the education sector. Some minor spelling errors are also evident. Finally, the chapter on coordination chemistry is extremely superficial, perhaps indicating that a future volume of the series will cover this topic in much greater detail.

In summary this unit is very quantitative, as expected for the content covered, but does contain some qualitative descriptions from the natural or industrial context to stimulate student interest.



Chemical Kinetics and Mechanism

M. Mortimer and P. G. Taylor (Eds)

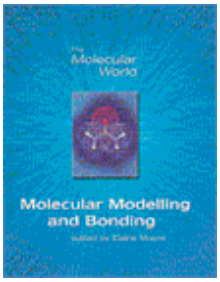
RSC, Cambridge
July 2002, 256 pp.
ISBN 0 85404 670 4
Softcover, 22.50 GBP

Chemical Kinetics and Mechanism (edited by Michael Mortimer and Peter Taylor) consists of four sections written by various authors. The first three sections covered form the general basis of this text book and is broken into three major themes of the subject: (i) Chemical Kinetics, (ii) The Mechanism of Substitution, and (iii) Elimination: Pathways and Products. The first section is by far the largest and provides the standard textbook approach to chemical kinetics and introduces the reader to reaction rates and order, the Arrhenius equation and temperature dependence, collision theory, reaction mechanisms and the concept of rate-limiting steps. The second and third sections are quite disparate from the opening chapters and involve the standard approach to teaching reaction mechanisms in organic chemistry. For example, the effect of nucleophiles, electrophiles and leaving groups on organic substitution reactions is examined. The mechanism of substitution reactions are then introduced and the mechanistic difference between S_N1 and S_N2 reactions are highlighted. This approach is followed for elimination reactions in section three. Each of these three sections concludes with a list of learning outcomes, a glossary of important terms and concepts, and detailed answers to questions and exercises referenced to the learning outcomes. The final section in the book concludes with an interesting discussion on the use of shape-selective catalysis of zeolites to provide reaction specificity in a range of chemical reactions.

In keeping with the apparent philosophy of the series, this volume is descriptive and does not attempt to derive equations from initial concepts. The use of mathematical equations is explained step-by-step with clear examples. This approach will aid distance education students.

As with the other titles in this series, the accompanying CD-ROM contains a suite of tools that significantly enhance the text. Students are able to use the application ISIS/Draw for generating structures, and WebLab ViewerLite for viewing molecules. The Kinetics Toolkit, in particular, allows for students to explore the relationships between observed kinetic data and hypothesized kinetic models. The Kinetics Toolkit is actually a simple spreadsheet application

and would allow for students to analyse almost any numeric data sets encountered in the course of their chemistry studies. However, as with the other titles in the series, it is a pity that the CD-ROM does not operate on Macintosh computers.



Molecular Modelling and Bonding

E. Moore (Ed.)

RSC, Cambridge
July 2002, 154 pp.
ISBN 0 85404 675 5
Softcover, 17.50 GBP

Molecular Modelling and Bonding (edited by Elaine Moore) provides an introductory coverage of molecular and quantum mechanical theories in an easy-to-read, largely non-mathematical fashion. Despite the book's title, the emphasis is strongly on molecular bonding rather than modelling, and only the basic ideas behind the latter are presented. Both inorganic and organic examples are used throughout the text.

The book commences somewhat unusually with an introduction to molecular mechanics and its application to the modelling of ionic solids such as zeolites and small organic molecules. The quantum theory of atoms is discussed in a traditional manner, and the reader is introduced to the idea of atomic orbitals (AOs) and hybridization. These concepts are abstract and can be difficult for many students to readily grasp. This is especially so when trying to relate the two-dimensional 'appearance' of atomic orbitals illustrated in the text to three-dimensions. A feature of the conceptual discussion given in this text is the way in which 'flags' to the interactive CD-ROM are integrated into the text so that students are alerted at the appropriate time to the opportunity to use the associated visualization software provided on the CD-ROM to aid in their understanding of this material.

Molecular Orbital (MO) theory for homo- and hetero-nuclear diatomic molecules is presented in substantial detail and is illustrated with numerous examples. This section is followed by an overview of MO theory as applied to simple polyatomic molecules such as water. The concept of delocalization is also introduced in this section. A chapter on symmetry discusses the standard systematic method for the analysis of symmetry elements in molecules, and a very short overview of various methods in molecular modelling that are currently available to the computational chemist is presented, e.g. density-functional theory.

The final chapter of the main body of the text deals with bonding in solids, particularly metals and semiconductors. A discussion of applications including photoconductivity and impurity semiconductors rounds out this section of the text. The text finishes up with a case study entitled, 'Molecular Modelling in Rational Drug Design' which provides an overview of the contemporary application of the concepts discussed throughout the text to chemical biology. An additional case study describing the role of molecular modeling in at least one other area of chemistry would have rounded the text out nicely.

As an aid to student learning, the authors have provided a concise summary of the desired learning outcomes, together with a cross reference to the page(s) of the text where a relevant term, concept or principle is introduced. The text is also punctuated with interesting historical anecdotes. The book is illustrated with some excellent three-dimensional boundary-surface diagrams of various AOs and MOs, but the two-dimensional representations are not particularly interesting or valuable to the student's understanding of the shapes of orbitals.

The accompanying CD-ROM contains a suite of tools that significantly enhance the text. However it is a great pity that this CD-ROM cannot be used on Macintosh computers.

** All of the reviewers are members of the Department of Chemistry, The University of Adelaide, and are actively involved in undergraduate teaching. Geoffrey Crisp is also a member of the Learning and Teaching Development Unit of the University of Adelaide.*