

conquering
chemistry
PRELIMINARY COURSE
FOURTH EDITION

*For Madeline, Aaron, Emily, Jacob,
Stephanie, Cameron, Victoria and Oscar,
whose energy and enthusiasm
have been truly inspiring*

conquering chemistry

PRELIMINARY COURSE

ROLAND SMITH

FOURTH EDITION

The McGraw-Hill Companies

Sydney New York San Francisco Auckland
Bangkok Bogotá Caracas Hong Kong
Kuala Lumpur Lisbon London Madrid
Mexico City Milan New Delhi San Juan
Seoul Singapore Taipei Toronto

First published 1987
Reprinted 1988, 1989, 1990, 1991, 1992, 1993
Second edition 1994
Reprinted 1995 (twice), 1998
Third edition 2000
Reprinted 2000 (twice), 2002, 2006

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National Library of Australia Cataloguing-in-Publication data:

Smith, Roland, 1937–.
Conquering Chemistry.

4th edn.

Includes index.

For senior secondary students.

ISBN 0 074 71493 7 (preliminary course)

1. Chemistry – Problems, exercises, etc. 2. Chemistry – Examinations, questions, etc. I. Title.

6540.712

Published in Australia by
McGraw-Hill Australia Pty Ltd
Level 2, 82 Waterloo Road, North Ryde NSW 2113

Acquisitions Editor: Libby Houston

Production Editor: Sybil Kesteven

Editor: Joy Window

Permissions Editor: Jill Roebuck

Proofreader: Tim Learner

Indexer: Glenda Browne

Designer (cover and interior): Jenny Pace

Cover image: Zefaimages Pty Ltd

Illustrator: Lorenzo Lucia

Typeset in Plantin by Jenny Pace

Printed on 80 gsm matt art by Best-Tri Colour Printing and Packaging, Hong Kong.

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Acknowledgments

The author and publisher wish to thank Keith Tonkin of Macquarie University Chemistry Department for providing space and access to equipment and chemicals in order for us to take many of the photos in this book.

Thanks are also due to the manuscript reviewers whose constructive comments and suggestions have made this a better book.

Finally the author wishes to record his deep and sincere thanks to Meryl Smith for her understanding, patience and help, particularly during the hectic period of preparing the manuscript for this book.

CREDITS

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About this book

Conquering Chemistry Fourth edition has been written to meet the requirements of the October 2002 revision of the New South Wales Board of Studies Chemistry Stage 6 Syllabus. Some comments about the approach and organisation of the book are warranted.

Approach to the syllabus

Conquering Chemistry presents a comprehensive coverage of the content of the syllabus, meaning the *Students learn to* (middle) column.

The coverage of material in the student activity (right-hand) column is more varied.

- Procedures for performing experiments (*first hand investigations*) are not included because a bulky textbook does not make a good instruction sheet to have open on a laboratory bench where spills and other accidents can cause extensive damage to the book. Instead, the publisher offers a book of blackline masters that includes, among other activities, details for all the compulsory experiments (Smith, D., *Conquering Chemistry Preliminary Course Blackline Masters*, McGraw-Hill, Sydney, 2003). However, the text does treat all the background theory and includes calculations required for experiments, both as worked examples and as exercises; in addition it includes experiments in the Exam-style Questions (see below) and in the Revision Tests, with useful information being provided in answers to these questions.
- For activities that require students to develop and use skills, such as writing equations and performing stoichiometric and other calculations, full treatment of the underlying theory and methods of approach, along with worked examples and student exercises, are included.
- For activities that require students to process, analyse or discuss information, the relevant information is generally included in the text.
- Some activities require students to collect and organise information, with the emphasis being upon the process of collecting and organising the information rather than on the information itself. Generally, information for this type of activity is not included in the text, though the activity is usually highlighted by being the subject of a *For Investigation* box.

- Activities involving building and evaluating models are treated to some extent, but are limited by the constraints of two-dimensional paper presentation.

Sequence of presentation of material

To a large extent, *Conquering Chemistry* follows syllabus order. Sometimes deviations from this sequence occur to allow the logical development of a series of chemical concepts without distracting detours; for example the chemical bonding of Syllabus Sections 8.2.3 and 8.2.5 are treated in Chapter 2, with Section 8.2.4 being in Chapter 3. At other times deviation occurs to allow a more logical sequence for introducing chemical concepts; for example, atomic weight is more naturally introduced in stoichiometric contexts rather than for the historical development of the Periodic Table; hence Section 8.3.4 is treated before Section 8.3.3.

Regardless of sequencing, the book presents a thorough treatment of syllabus material, but equally importantly, it contains very little material that is outside the syllabus. On the few occasions where non-syllabus material has been included, footnotes are used to indicate this.

General structure

Each module begins with a general introduction setting out its purpose and scope. There are then two or three chapters treating the material, followed by a set of Exam-style Questions and a 90 minute Revision Test. Finally, there is a section called *Module x and the HSC Syllabus*. This presents tables showing where each syllabus item is treated in the book, where information can be found for the compulsory experiments, how and where items in the student activity column have been treated and a brief comment on how the material relates to the Prescribed Focus Areas of the syllabus.

Structure of chapters

Each chapter starts with a section called *In this chapter*, which lists the main topics to be discussed. At the end of the chapter is a list of *Important new terms* with page references to definitions or explanations and finally a set of *Test yourself* questions for students to see whether they have gained the required knowledge.

Sets of exercises are located throughout the chapters at places where the author considers it is appropriate to pause and consolidate learning by applying it to problem-solving.

Exercises, Test yourself, Exam-style questions, Revision tests

- *Exercises* are simple calculations and problems interspersed through the text. They are intended to consolidate understanding and use of the concepts just discussed. At least some of them should be done as students work through the chapter.
- *Test yourself* is a set of questions to let students check that they have learnt the necessary facts from the chapter. They are not problems; they just test factual knowledge.
- *Exam-style questions* (at the end of each module) are in the style that is

currently being used for ‘extended response’ questions in HSC Chemistry examinations: they use the HSC list of verbs (such as assess, compare, contrast, describe, discuss, evaluate, explain, justify, outline, propose) and place heavy emphasis upon recall of learnt information. They do not involve problem-solving. Recall of learnt information is much more important in the post-2000 HSC examination than it was previously.

- *Revision test* is a mini-HSC exam (at the end of each module). It combines problem-solving questions with extended response questions and is intended to help students develop the exam skills they will need for the actual HSC exam.

Exercises with asterisks

Answers are provided for all numerical exercises and for more than half the non-numerical ones (explain why, draw structures, write equations, etc). Unanswered exercises are generally the latter parts of multi-part questions or ones that are similar to a previous question for which an answer has been given.

Exercises (or parts thereof) without answers have an asterisk before them.

Answers are given for all *Exam-style questions* and *Revision tests*.

The Conquering Chemistry website

There is a *Conquering Chemistry* website at the address:

www.cci.net.au/ConqChem

For each module or chapter the site contains comments about the syllabus, explanations for the approach or sequence adopted by the book, further information about the topics of the chapter (generally outside the syllabus, but often relevant and interesting) and further exercises (some more challenging).

Most importantly, this website will be updated to meet any further fine-tuning of the syllabus that may occur after publication of the book.

Other Internet sites

Occasionally throughout the book there are addresses of Internet sites that contain useful and relevant information to supplement this book or to meet syllabus requirements. Brief notes about what the site contains and how to reach the relevant information are included. Websites do have a tendency to appear, disappear or change addresses quite rapidly, so be prepared to have the occasional site turn up ‘address unknown’! The lists provided are not exhaustive, so students are encouraged to do their own searching for other relevant sites.

To the student

The aim of *Conquering Chemistry* is to help you understand and use the basic concepts of chemistry and develop an appreciation of the way chemistry is involved in your life and in the world we live in. The emphasis is on ‘help’. You must make the real effort and do the hard work to gain that understanding and appreciation; no book or teacher can do it for you. But if you do make the effort, you will soon come to enjoy chemistry and the fascinating insights it provides into the world around us. The key to success is studying effectively.

Effective study methods

For a good understanding of chemistry you need to study regularly, methodically and without distractions, and you need to *apply* your knowledge to problem-solving and to test yourself frequently on what you have learnt.

When you have a new piece of work to study, first skim through the chapter or portion of a chapter to quickly get an idea of what it is about. Then read it carefully to understand what is being said, paying particular attention to the examples and illustrations, because they often get the message across better than mere descriptions. Write out and learn the important definitions and laws as they are introduced. Just as you cannot speak Italian or Indonesian until you know the vocabulary, so too you cannot talk chemistry unless you know the meaning of technical terms and the important laws.

When you think that you understand the material and know the necessary facts, try some of the exercises. Try them when they occur in the text—they have been placed at strategic points where the author thinks your understanding will be helped by working some examples. Generally in each set of exercises the early ones are very simple, but gradually they get harder as you progress through the set. Answers are provided for all numerical exercises and for most of the non-numerical ones. Many of the exercises have several parts. There is no need to work all parts on your first time through the book. Work the first half or so of them, and keep the rest for revision. Do not despair if you find the exercises difficult at first: go back over the text, particularly the worked examples, then if you are still having difficulty, ask your teacher or a friend to help you with the first one or two, then try the rest on your own. Eventually you must be able to solve exercises on your own, so do not rely on helpers for too long!

Self-testing

When you think that you have mastered a topic, check that you have absorbed the essential facts and concepts from the chapter by trying the *Test yourself* questions. These questions highlight the key points of the chapter and allow you to check that you have absorbed them. Whenever you revise a chapter—and frequent revision is necessary in order to remember what you have learnt—use these *Test yourself* sets. You haven't really learnt the material of the chapter until you can answer those simple questions!

You will enjoy chemistry when you can succeed at it (just as you enjoy tennis, netball or dancing when you can do it properly) and success in chemistry, as well as in sports, requires perseverance and practice.

Key aspects

Three of the key aspects of succeeding at chemistry are:

- being able to write formulae for compounds without having to memorise them;
- being able to write chemical equations for common types of reactions, regardless of which particular compounds are involved; and
- being able to do simple quantity calculations based on chemical formulae and equations.

Hence this book places great emphasis on developing these skills—they take time, patience and perseverance for mastery, but the rewards are worth it.

In chemistry, as in mathematics and physics, the emphasis is on using the information acquired—working exercises and solving problems. Assimilation of facts is necessary but it is not sufficient. So develop the habit of working exercises—and persevering with them until you get them correct—right from the beginning of your course.

Preparing for the New South Wales HSC examination

Understanding chemistry and being able to apply concepts to problem-solving situations is no longer sufficient to guarantee a good mark in the New South Wales HSC examination. You now (since 2000) need to be able to assess, compare and contrast, demonstrate, discuss, evaluate, explain, justify, etc. various aspects of the subject in what are called 'extended-response' questions. Even when you understand the chemical concepts and can apply them to problems, these extended response questions are often not easy to answer 'cold' (that is, without having seen or thought about the question in advance). So to maximise your marks in the HSC exam, you need to develop skills for answering such questions and the best way to do this is by a lot of practice, with feedback on your efforts. To help you develop these necessary skills *Conquering Chemistry* presents a set of such extended response questions for each module; in this book they are called *Exam-style questions*. Advice about how to tackle these questions and what examiners would expect in your answers, along with sample answers for many of them, are included in the Answers section of this book. The use of such questions in the HSC examination means that chemistry students now need to memorise a lot more information than they did before 2001. While extended

response questions based on the Preliminary Course material are unlikely to occur in the actual HSC examination, you need to practise answering such questions early in your two-year preparation for your HSC exam if you want to score well on them; that is the reason for including them in this book.

The HSC examination will be a mixture of these extended response questions and problem-solving questions similar to the exercises throughout the chapters of this book.

When you have finished studying a complete module and worked most of the exercises in the chapters and many of the Exam-style questions, and consider that you have a reasonable grasp of the material, try the *Revision test* at the end of the module. Revision tests are similar to HSC examinations: they are mixes of problem-solving and extended response questions and have the topics in random order.

Other useful study hints

Some further hints are:

- *Use the index!* If, in studying a particular chapter, a technical term is used which you cannot remember the meaning of, look it up in the index to find the relevant section in the book so you can better understand the argument at hand. That is not wasting time—it is effective learning.
- *Look up cross-references.* If the topic you are currently reading refers to a previous section, look it up to make sure you know what it is all about. Interconnecting today's study with last week's or last month's work is an important part of learning.
- *Set out your exercises systematically and neatly.* This will help you develop logical arguments and make it easy for you to check for errors in your work or for your teacher to diagnose where you are having problems. The worked examples in this text have been set out in ways that should serve as good models for your own work.
- If you are having difficulty with exercises based on a particular topic, take the time to read the relevant part of the text carefully and study it thoroughly. Do not just grab a formula or copy a worked example. Time spent getting to understand the basic idea is definitely not time wasted—even when the object is to get some homework exercises done!

Classroom wits will soon discover that there are two ways of taking the title of this book. The author is confident that, with reasonable effort, you will be able to take it as intended—as you mastering chemistry. Good study and good luck!

The NSW Board of Studies' list of verbs

The NSW Board of Studies has prepared a list of definitions of the verbs that are used in its syllabus documents. Since 2000 these verbs have figured prominently in HSC examinations (in the extended-response questions). The list of definitions is reproduced here (with permission). The verbs are intended for a wide range of subjects, so the definitions are quite broad. Following HSC examination usage, the exam-style questions in this book use these verbs. In the comments and answers to these questions the meaning of these verbs in specific contexts is explained more fully.

Account *Account for:* state reasons for, report on

Give an account of: narrate a series of events or transactions

Analyse Identify components and the relationship among them; draw out and relate implications

Apply Use, utilise, employ to a particular situation

Appreciate Make a judgement about the value of

Assess Make a judgement of value, quality, outcomes, results or size

Calculate Ascertain/determine from given facts, figures or information

Clarify Make clear or plain

Classify Arrange or include in classes/categories

Compare Show how things are similar or different

Construct Make; build; put together items or arguments

Contrast Show how things are different or opposite

Critically (analyse/evaluate) Add a degree or level of accuracy depth, knowledge and understanding, logic, questioning, reflection and quality to (analysis/evaluation)

Deduce Draw conclusions

Define State meaning and identify essential qualities

Demonstrate Show by example

Describe Provide characteristics and features

Discuss Identify issues and provide points for and/or against

Distinguish Recognise or note/indicate as being distinct or different from; to note differences between

Evaluate Make a judgement based on criteria; determine the value of

Examine Inquire into
Explain Relate cause and effect; make the relationships between things evident; provide why and/or how
Extract Choose relevant and/or appropriate details
Extrapolate Infer from what is known
Identify Recognise and name
Interpret Draw meaning from
Investigate Plan, inquire into and draw conclusions about
Justify Support an argument or conclusion
Outline Sketch in general terms; indicate the main features of
Predict Suggest what may happen based on available information
Propose Put forward (for example a point of view, idea, argument, suggestion) for consideration or action
Recall Present remembered ideas, facts or experiences
Recommend Provide reasons in favour
Recount Retell a series of events
Summarise Express concisely the relevant details