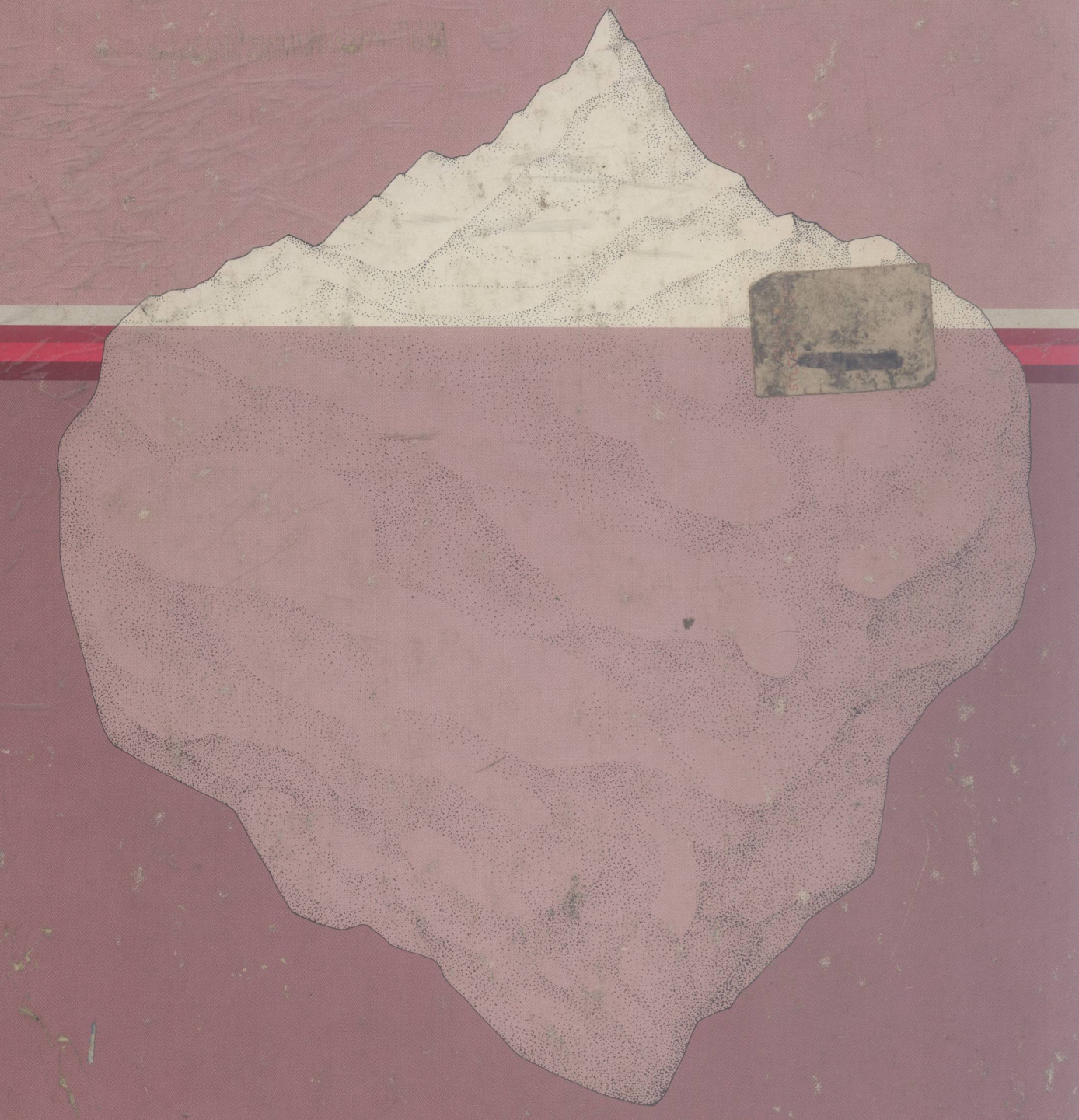
Second Edition

CHEM ONE

JÜRG WASER
KENNETH N. TRUEBLOOD
CHARLES M. KNOBLER



Chem One Second Edition

JÜRG WASER
Formerly, Department of Chemistry, California Institute of Technology

KENNETH N. TRUEBLOOD
Department of Chemistry, University of California, Los Angeles

CHARLES M. KNOBLER
Department of Chemistry, University of California, Los Angeles

McGraw-Hill Book Company

New York St. Louis San Francisco Auckland Bogotá Hamburg
Johannesburg London Madrid Mexico Montreal New Delhi Panama
Paris São Paulo Singapore Sydney Tokyo Toronto

Chem One

Copyright © 1980, 1976 by McGraw-Hill, Inc. All rights reserved. Printed in the United States of America. No part of this publication may be reproduced, stored in a retrieval system, or transmitted, in any form or by any means, electronic, mechanical, photocopying, recording, or otherwise, without the prior written permission of the publisher.

4567890 RMRM 832

This book was set in Century Schoolbook by York Graphic Services, Inc. The editors were Jay Ricci, Donald C. Jackson, and Sibyl Golden; the designer was Janet Durey Bollow; the production supervisor was Charles Hess. New drawings were done by Judith L. McCarty. Rand McNally & Company was printer and binder.

Library of Congress Cataloging in Publication Data

Waser, Jürg.
Chem one.

Bibliography: p.
Includes index.
1. Chemistry. I. Trueblood, Kenneth N., joint author. II. Knobler, Charles M., date joint author. III. Title.
QD31.2.W36 1980 540 79-15670
ISBN 0-07-068432-4

Table of Atomic Weights 1973*

Name	Symbol	Atomic number	Atomic weight
Actinium	Ac	89	(227)
Aluminum	Al	13	26.98
Americium	Am	95	(243)
Antimony	Sb	51	121.75
Argon	Ar	18	39.95
Arsenic	As	33	74.92
Astatine	At	85	(210)
Barium	Ba	56	137.34
Berkelium	Bk	97	(247)
Beryllium	Be	4	9.01
Bismuth	Bi	83	208.98
Boron	B	5	10.81
Bromine	Br	35	79.90
Cadmium	Cd	48	112.40
Calcium	Ca	20	40.08
Californium	Cf	98	(251)
Carbon	C	6	12.01
Cerium	Ce	58	140.12
Cesium	Cs	55	132.91
Chlorine	Cl	17	35.45
Chromium	Cr	24	52.00
Cobalt	Co	27	58.93
Copper	Cu	29	63.55
Curium	Cm	96	(247)
Dysprosium	Dy	66	162.50
Einsteinium	Es	99	(254)
Erbium	Er	68	167.26
Europium	Eu	63	151.96
Fermium	Fm	100	(257)
Fluorine	F	9	19.00
Francium	Fr	87	(223)
Gadolinium	Gd	64	157.25
Gallium	Ga	31	69.72
Germanium	Ge	32	72.59
Gold	Au	79	196.97
Hafnium	Hf	72	178.49
Helium	He	2	4.00
Holmium	Ho	67	164.93
Hydrogen	H	1	1.01
Indium	In	49	114.82
Iodine	I	53	126.90
Iridium	Ir	77	192.22
Iron	Fe	26	55.85
Krypton	Kr	36	83.80
Lanthanum	La	57	138.91
Lawrencium	Lw	103	(260)
Lead	Pb	82	207.2
Lithium	Li	3	6.94
Lutetium	Lu	71	174.97
Magnesium	Mg	12	24.30
Manganese	Mn	25	54.94
Mendelevium	Md	101	(258)
Mercury	Hg	80	200.59
Molybdenum	Mo	42	95.94
Neodymium	Nd	60	144.24
Neon	Ne	10	20.18
Neptunium	Np	93	237.05
Nickel	Ni	28	58.70
Niobium	Nb	41	92.91
Nitrogen	N	7	14.01
Nobelium	No	102	(255)
Osmium	Os	76	190.2
Oxygen	O	8	16.00
Palladium	Pd	46	106.4
Phosphorus	P	15	30.97
Platinum	Pt	78	195.09
Plutonium	Pu	94	(244)
Polonium	Po	84	(209)
Potassium	K	19	39.10
Praseodymium	Pr	59	140.91
Promethium	Pm	61	(145)
Protactinium	Pa	91	231.04
Radium	Ra	88	226.03
Radon	Rn	86	(222)
Rhenium	Re	75	186.21
Rhodium	Rh	45	102.91
Rubidium	Rb	37	85.47
Ruthenium	Ru	44	101.07
Samarium	Sm	62	150.4
Scandium	Sc	21	44.96
Selenium	Se	34	78.96
Silicon	Si	14	28.09
Silver	Ag	47	107.87
Sodium	Na	11	22.99
Strontium	Sr	38	87.62
Sulfur	S	16	32.06
Tantalum	Ta	73	180.95
Technetium	Tc	43	(97)
Tellurium	Te	52	127.60
Terbium	Tb	65	158.93
Thallium	Tl	81	204.37
Thorium	Th	90	232.04
Thulium	Tm	69	168.93
Tin	Sn	50	118.69
Titanium	Ti	22	47.90
Tungsten (Wolfram)	W	74	183.85
Uranium	U	92	238.03
Vanadium	V	23	50.94
Xenon	Xe	54	131.30
Ytterbium	Yb	70	173.04
Yttrium	Y	39	88.91
Zinc	Zn	30	65.38
Zirconium	Zr	40	91.22

*Rounded values based on $^{12}C = 12$.

Periodic Table of the Elements with Atomic Weights*

1 H 1.0079																	2 He 4.00260
3 Li 6.941	4 Be 9.01218											5 B 10.81	6 C 12.011	7 N 14.0067	8 O 15.9994	9 F 18.99840	10 Ne 20.179
11 Na 22.98977	12 Mg 24.305											13 Al 26.98154	14 Si 28.086	15 P 30.97376	16 S 32.06	17 Cl 35.453	18 Ar 39.948
19 K 39.098	20 Ca 40.08	21 Sc 44.9559	22 Ti 47.90	23 V 50.9414	24 Cr 51.996	25 Mn 54.9380	26 Fe 55.847	27 Co 58.9332	28 Ni 58.70	29 Cu 63.546	30 Zn 65.38	31 Ga 69.72	32 Ge 72.59	33 As 74.9216	34 Se 78.96	35 Br 79.904	36 Kr 83.80
37 Rb 85.4678	38 Sr 87.62	39 Y 88.9059	40 Zr 91.22	41 Nb 92.9064	42 Mo 95.94	43 Tc (97)	44 Ru 101.07	45 Rh 102.9055	46 Pd 106.4	47 Ag 107.868	48 Cd 112.40	49 In 114.82	50 Sn 118.69	51 Sb 121.75	52 Te 127.60	53 I 126.9045	54 Xe 131.30
55 Cs 132.9054	56 Ba 137.34	57 La 138.9055	72 Hf 178.49	73 Ta 180.9479	74 W 183.85	75 Re 186.207	76 Os 190.2	77 Ir 192.22	78 Pt 195.09	79 Au 196.9665	80 Hg 200.59	81 Tl 204.37	82 Pb 207.2	83 Bi 208.9804	84 Po (209)	85 At (210)	86 Rn (222)
87 Fr (223)	88 Ra 226.0254	89 Ac (227)	104 (Rf)	105 (Ha)	106												

Transition elements

Lanthanides	58 Ce 140.12	59 Pr 140.9077	60 Nd 144.24	61 Pm (145)	62 Sm 150.4	63 Eu 151.96	64 Gd 157.25	65 Tb 158.9254	66 Dy 162.50	67 Ho 164.9304	68 Er 167.26	69 Tm 168.9342	70 Yb 173.04	71 Lu 174.97
Actinides	90 Th 232.0381	91 Pa 231.0359	92 U 238.029	93 Np 237.0482	94 Pu (244)	95 Am (243)	96 Cm (247)	97 Bk (247)	98 Cf (251)	99 Es (254)	100 Fm (257)	101 Md (258)	102 No (255)	103 Lw (260)

*1973 values based on $^{12}C = 12$.

此为试读，需要完整PDF请访问：www.ertongbook.com

Chem One

McGraw-Hill Series in Chemistry

David L. Adams, Educational Consultant

Burgoyne: A SHORT COURSE IN ORGANIC CHEMISTRY
Companion: CHEMICAL BONDING
Compton: INSIDE CHEMISTRY
Durst and Gokel: EXPERIMENTAL ORGANIC CHEMISTRY
Kroschwitz and Winokur: CHEMISTRY: A FIRST COURSE
Pine, Hendrickson, Cram, and Hammond: ORGANIC CHEMISTRY
Roach and Leddy: BASIC COLLEGE CHEMISTRY
Russell: GENERAL CHEMISTRY
Sienko and Plane: CHEMISTRY: PRINCIPLES AND APPLICATIONS
Waser, Trueblood, and Knobler: CHEM ONE

Preface

"Chem One" is a text for a first-year college or university course for students planning careers in the physical and life sciences and in engineering. This second edition is a considerable revision of the first edition that was published four years ago.

We have attempted to avoid the pitfalls of half-truth and misleading oversimplification. A book with such a goal need not, however, *begin* each topic on an advanced level. We have tried, through careful definitions, rather full explanations, and many worked examples with parallel exercises, to provide the means by which a student who is willing to work can master the fundamental concepts and be able to apply them. Those whose preparation has been inadequate should find that the "Study Guide" prepared for this edition by Emily Maverick will make the task easier.

Certain concepts are encountered a number of times, first in an introductory fashion in the early chapters, then again in greater depth and sophistication in the middle sections of the book, and finally still again as they are used in the discussions of descriptive chemistry that comprise the final eight chapters. In addition to the pedagogical advantages that accompany repeated exposure at increasing depth, including a better overall perspective on the unifying themes of chemistry, this scheme makes it possible for students to do significant laboratory experiments during the early stages of the course. Thus errors, stoichiometry, and gases are treated in detail in Chapters 3 and 4, and discussions of the periodic table, bonding, three-dimensional structure, and reactions in aqueous solution are introduced in an elementary fashion in the first third of the book. Chapters 11 through 13 contain a detailed treatment of chemical equilibrium to facilitate the early introduction of quantitative laboratory work (such as titrations) that requires an understanding of equilibria in solution. The detailed discussion of quantum theory, atomic and molecular structure, and the periodic table is taken up in the middle of the book (Chapters 14 through 18), but these chapters may readily be assigned as a unit either earlier (e.g., after Chapter 7 or Chapter 10) or

later (after Chapter 22). The structure of the book allows several other variations in order of presentation as well. For courses in which laboratory experiments dealing with solutions are begun as early as the fourth or fifth week, Chapters 4 (gases) and 7 may be deferred, allowing Chapters 8 and 9 to be covered earlier.

We have again used the SI system primarily, because those being trained now will doubtless use SI units throughout most of their working lives. However, we have retained the atmosphere, the torr, and the angstrom, and we have not completely given up the milliliter in favor of the identical cubic centimeter because students will use glassware calibrated in milliliters. Table headings, labels on the axes of graphs, and some equations are written in "slash" notation. In this convention, dimensioned quantities are divided by their units to give dimensionless numbers. Thus, we write log (P/atm), which represents the logarithm of a number, the pressure in atmospheres divided by the unit atmosphere. Each of the SI conventions is explained when it is introduced and the SI system is discussed in Chapter 1 and, in detail, in Appendix A.

In any book as comprehensive as this there are topics or sections that can be omitted or abridged to suit the tastes of the instructor and the students as well as the limitations of time. We have attempted to relegate the more advanced and least essential material to the latter parts of many chapters so that they may most readily be skipped. Some sections of the book can be left for the student to read and need not be discussed extensively in class. Chapter 7, for example, can stand on its own as an introduction to structure. With selective omissions, a lecturer could have time to devote at least three weeks to organic chemistry and biochemistry, which comprise the final two chapters, if this is felt desirable. Although the latter are often found in second-year courses, there are many students who do not continue beyond the first year. It seems to us essential that any general chemistry book provide such students with some exposure to these important areas of modern chemistry, even if they are not covered in formal course work.

The following are among the more significant changes from the first edition:

1. The number of worked examples has been increased to 165 and each is now accompanied by a parallel exercise with which students can test their understanding.
2. The number of end-of-chapter problems and questions has been increased by about one-third, with particular emphasis on straightforward, relatively simple, problems.
3. Each chapter concludes with a summary and a list of new terms and concepts, with a page reference to the introduction of each term or concept so that it may be reviewed in context rather than as a disconnected entity.
4. Many sections of the book have been completely rewritten, and much of the material has been reorganized, with the number of chapters increased by three although the text as a whole is somewhat shorter. There are new chapters on oxidation and reduction (Chapter 10) and nuclear chemistry (Chapter 28), and an early overview of the periodic table (in Chapter 2).
5. Derivations using calculus notation explicitly have now been put into Appendix C, with only the results in the text itself, in the chapters dealing with thermodynamics and kinetics.
6. The term *formality* and the related symbol F have been abandoned because so few instructors distinguish between formality and molarity. The terms

equivalent weight and *normality* have also been removed because they are useful chiefly in a laboratory context and can readily be learned there, as needed. (The principles behind them remain, however; for example, in Problems 9-14 through 9-17, 10-9, and 10-10.)

In this revision we have benefited greatly from the advice, suggestions, and criticism of many students and colleagues at UCLA and elsewhere, and especially from those of David Adams, Robert Allendoerfer, Daniel Atkinson, Kyle Bayes, James Espensen, Jerry Kasper, Ed Lingafelter, Sam Markowitz, Emily Maverick, George Miller, Verner Schomaker, Bernice Segal, Arden Slotter, and Charles West. We owe a great deal to them, as we do to those others who contributed to the first edition in various ways, including Jay M. Anderson, Bill Benjamin, John P. Chesick, Deirdre Devereux, Ed Friedrich, Jenny Glusker, James B. Ifft, Daniel Kivelson, Caroline Lanford, Richard Marsh, James D. McCullough, Kathy North, Julian L. Roberts, Jr., Raymond J. Suplinskas, Judy Swain, Julie Swain, Robert Weiss, and Alan Wingrove.

We have appreciated the professionalism and talent of Janet Bollow, the designer; of Judith McCarty, who prepared the new figures; of John Hannon, who copyedited the manuscript; and of Donald Jackson, Sibyl Golden, and Charles Hess, who have supervised the various stages of editing and production with patience and encouragement. Finally, we owe a very special debt to Delna Jacobs, whose skill and unfailing good spirits in typing the revisions of revisions of revisions has made our task much easier and more pleasant.

Jürg Waser
Kenneth N. Trueblood
Charles M. Knobler

To the Student

The material in this book varies widely in difficulty. Some topics may seem essentially a review of high school chemistry, whereas others will be new to all students and sometimes rather abstract. Many topics are treated a number of times so that you can become familiar with them while working with them. They are first encountered at an elementary and qualitative level, are later developed in more detail, often quantitatively, and finally turn up again when they are utilized in systematizing and explaining the great body of chemical facts called "descriptive chemistry".

Not all of the material in the book is easy to grasp. We and most of our colleagues in chemistry had to struggle with many parts of it when we were learning it and have to think about some aspects of it carefully even now. We have, however, tried to smooth the way for you. New words are italicized when they are first defined, and the key terms and concepts new to each chapter are listed at the end of the chapter, with a specific page reference that will help you find the place where each is introduced and discussed, in context, in the chapter. The extensive index should also be helpful in this connection. Each chapter has a summary at the end; make it a practice to read this after you have finished studying the chapter to be sure that you have grasped all of the essential points. You may also find it helpful to get an overview by scanning the summary before studying the chapter.

Many of the figures have extensive legends which are intended to clarify both the figures and the accompanying text. Make it a habit to read them carefully. You will find many worked examples in most chapters, designed to show you how to apply principles and methods to specific situations. Each example is accompanied by a parallel exercise, which you should be able to do without difficulty if you have followed through and understood the example. Each chapter concludes with many problems and questions that will help you develop your ability to work with chemical concepts.

Frequent cross-references tie together related concepts and facts found in

此为试读，需要完整PDF请访问：www.ertongbook.com

different sections of the book. Anyone learning a new subject finds it hard at times to see interrelationships and to appreciate general principles; the cross-references are intended to help provide a broader perspective. Appendixes A and B are self-contained essays on special topics (Units and Chemical Nomenclature) that you may want to consult a number of times. Appendix C presents derivations by the methods of calculus of some of the equations used in chemical thermodynamics (Chapters 19 and 20) and in the discussion of the rates of chemical reactions (Chapter 22). Appendix D contains tables of data that you will need to refer to often. Appendix E gives answers to all exercises and to many odd-numbered end-of-chapter problems and questions. Frequently used tables are to be found inside the front and back covers.

The "Study Guide" that accompanies the book should prove helpful, especially for those students whose background in chemistry is weak and in those places in the text where some background in physics or mathematics is essential for a thorough understanding. The "Solutions and Supplementary Material" manual that also accompanies the text provides detailed solutions and answers for every end-of-chapter problem and question. In addition, it contains supplementary material on some topics that may be of interest to those students who find their curiosity piqued but their questions not entirely answered by the material in the text.

We suggest that when the going gets tough, as it will at times, you give the more difficult material a rest after a first cursory reading. Follow up later with a second, more careful, study, jotting down key words and concepts and frequently closing the book for quick mental reviews. Retrace the steps of derivations and check the details of the worked examples. Work or rework the exercises. Don't worry if at first you understand some new topic only partially and even have some wrong ideas about it. Often an initial false start that is later corrected helps to clarify something, because it gives a perspective not available to someone who has not thought about the topic at all.

Try to retain a critical attitude at all times. Don't accept anything stated here, or elsewhere, simply on the basis of the apparent authority of the source. Apply your powers of reasoning as much as you can; search for internal consistency. We have tried to avoid errors but it is unlikely that we have caught them all.

Learning is a lonely pursuit and takes a good deal of discipline. Yet all these sober words of caution and advice should not obscure the fact that chemists really *enjoy* chemistry. We know that you can too—and we hope you will.

Jürg Waser
Kenneth N. Trueblood
Charles M. Knobler

Chem One

Contents in Brief

Contents

9362427

此为试读，需要完整PDF请访问：www.ertongbook.com