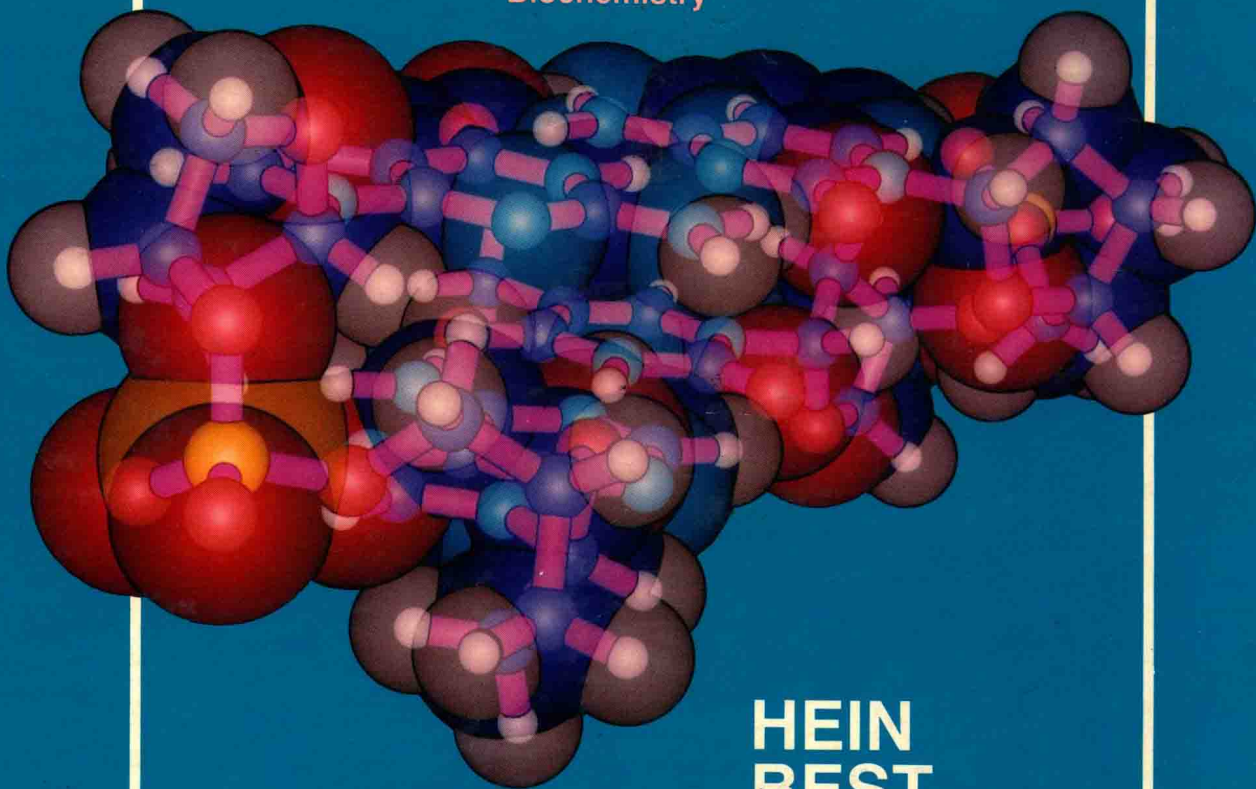


COLLEGE CHEMISTRY

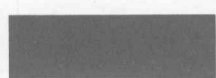
An Introduction
to General,
Organic, and
Biochemistry

FOURTH
EDITION



HEIN
BEST
PATTISON

0042443



College Chemistry

An Introduction to General, Organic, and Biochemistry

Fourth Edition

Morris Hein
Leo R. Best
Scott Pattison

Brooks/Cole Publishing Company
Pacific Grove, California

Brooks/Cole Publishing Company

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Periodic Table of the Elements

Group IA

Period
1

1 Hydrogen H 1.0079

IIA

2

3 Lithium Li 6.941	4 Beryllium Be 9.01218
------------------------------------	--

3

11 Sodium Na 22.98977	12 Magnesium Mg 24.305
---------------------------------------	--

Atomic number	→ 11
Name	→ Sodium
Symbol	→ Na
Atomic weight	→ 22.98977

^aMass number of most stable
or best-known isotope

^bMass of the isotope of longest half-life

Transition elements

4

19 Potassium K 39.098	20 Calcium Ca 40.08	21 Scandium Sc 44.9559	22 Titanium Ti 47.90	23 Vanadium V 50.9414	24 Chromium Cr 51.996	25 Manganese Mn 54.9380	26 Iron Fe 55.847	27 Cobalt Co 58.9332
--	--	---	---	--	--	--	--	---

5

37 Rubidium Rb 85.4678	38 Strontium Sr 87.62	39 Yttrium Y 88.9059	40 Zirconium Zr 91.22	41 Niobium Nb 92.9064	42 Molybdenum Mo 95.94	43 Technetium Tc 98.9062 ^b	44 Ruthenium Ru 101.07	45 Rhodium Rh 102.9055
--	---------------------------------------	--------------------------------------	---------------------------------------	---------------------------------------	--	---	--	--

6

55 Cesium Cs 132.9054	56 Barium Ba 137.34	57 Lanthanum La [*] 138.9055	72 Hafnium Hf 178.49	73 Tantalum Ta 180.9479	74 Wolfram (Tungsten) W 183.85	75 Rhenium Re 186.2	76 Osmium Os 190.2	77 Iridium Ir 192.22
---------------------------------------	-------------------------------------	---	--------------------------------------	---	---	-------------------------------------	------------------------------------	--------------------------------------

7

87 Francium Fr (223) ^a	88 Radium Ra 226.0254 ^b	89 Actinium Ac ^{**} (227) ^a	104 Unnilquadium Unq (261) ^a	105 Unnilpentium Unp (262) ^a	106 Unnilhexium Unh (263) ^a	107 Unnilseptium Uns		109 Unnilennium Une
---	--	---	---	---	--	-----------------------------------	--	----------------------------------

*
6

Lanthanide series

**
7

Actinide series

58 Cerium Ce 140.12	59 Praseodymium Pr 140.9077	60 Neodymium Nd 144.24	61 Promethium Pm (145) ^a	62 Samarium Sm 150.4
90 Thorium Th 232.0381 ^b	91 Protactinium Pa 231.0359 ^b	92 Uranium U 238.029	93 Neptunium Np 237.0482	94 Plutonium Pu (242) ^a

Noble gases

Atomic weights are based on carbon-12. Atomic weights in parentheses indicate the most stable or best-known isotope. Slight disagreement exists as to the exact electronic configuration of several of the high-atomic-number elements.

Atomic weights are based on carbon-12. Atomic weights in parentheses indicate the most stable or best-known isotope. Slight disagreement exists as to the exact electronic configuration of several of the high-atomic-number elements.								2 Helium He 4.00260
			IIIA	IVA	VA	VIA	VIIA	
			5 Boron B 10.81	6 Carbon C 12.011	7 Nitrogen N 14.0067	8 Oxygen O 15.9994	9 Fluorine F 18.99840	10 Neon Ne 20.179
			13 Aluminum Al 26.98154	14 Silicon Si 28.086	15 Phosphorus P 30.97376	16 Sulfur S 32.06	17 Chlorine Cl 35.453	18 Argon Ar 39.948
			IB	IIB				
28 Nickel Ni 58.71	29 Copper Cu 63.546	30 Zinc Zn 65.38	31 Gallium Ga 69.72	32 Germanium Ge 72.59	33 Arsenic As 74.9216	34 Selenium Se 78.96	35 Bromine Br 79.904	36 Krypton Kr 83.80
46 Palladium Pd 106.4	47 Silver Ag 107.868	48 Cadmium Cd 112.40	49 Indium In 114.82	50 Tin Sn 118.69	51 Antimony Sb 121.75	52 Tellurium Te 127.60	53 Iodine I 126.9045	54 Xenon Xe 131.30
78 Platinum Pt 195.09	79 Gold Au 196.9665	80 Mercury Hg 200.59	81 Thallium Tl 204.37	82 Lead Pb 207.2	83 Bismuth Bi 208.9804	84 Polonium Po (210) ^a	85 Astatine At (210) ^a	86 Radon Rn (222) ^a



College Chemistry

An Introduction to General, Organic, and Biochemistry

Fourth Edition

To Edna, Louise, and Joan

To Edna, Louise, and Joan

Preface

As in the previous editions, the primary purpose of this edition of *College Chemistry* is to instruct students in the basic concepts of chemistry. This book is intended for students who, although not majoring in chemistry, require a basic course in the subject that includes an introduction to organic chemistry and biochemistry. The text is written with the assumption that the students have not taken a previous chemistry course.

Many students are somewhat apprehensive about beginning the study of chemistry. Accordingly, one of our major goals has been to present the subject in a well-organized and readily understandable fashion. Each chapter was written with this thought in mind: Is our language clear—will the student be able to understand this material?

A fair amount of quantitative reasoning is essential to the study of chemistry. Therefore, another major goal has been to provide careful, step-by-step explanations of the topics that require quantitative reasoning. These explanations are then illustrated by one or more problems. These example problems are generally set up and worked by the conversion-factor dimensional analysis approach. This approach has proven to be an effective tool and requires no mathematics beyond arithmetic and elementary algebra. From experience, however, we know that to develop sufficient skill in quantitative reasoning, most students need considerable practice in working numerical problems. Consequently, we have provided

many end-of-chapter problems. To save student time, an inexpensive electronic calculator is recommended for the calculations needed in these problems.

In preparation for this revision, a number of instructors who are actual or potential users of the text submitted detailed reviews and comments on the text. These colleagues provided many suggestions for changes both in content and arrangement; a number of changes in the present text were based on these helpful suggestions.

Learning Aids

The following features are intended to serve as learning aids and to make the text convenient to use—a book that students can read, understand, and study by themselves.

- A list of achievement goals is given at the beginning of each chapter as a guide to students.
- Important new terms are set in boldface type where they are defined in the text, and they are also printed in color in the margin.
- A detailed discussion of significant figures, rounding off numbers, scientific notation of numbers, and the use of dimensional analysis in calculations is given in Chapter 2. Appendix I contains a concise review of the mathematics pertinent to *College Chemistry*.
- Numerous questions and problems are given in separate groups at the end of each chapter. These questions are generally arranged in the order in which the topics are discussed. A few of the more challenging problems are marked with asterisks. Answers to all mathematical problems are given in Appendix V.
- All chapters have at least one self-evaluation question that contains a fairly large number of “correct” or “not correct” statements. Answers to these questions are given in Appendix V.
- The mole is used as a unifying chemical concept wherever possible.
- Material on inorganic nomenclature appears in several chapters, but for convenient reference the basic rules for naming inorganic compounds are brought together in Chapter 8.
- Examples relating to health topics are used extensively.

Supplementary Materials

Supplementary materials that accompany *College Chemistry* are a student study guide, a laboratory manual, and a solutions manual.

Major Changes and Additions

- The concepts of the mole and Avogadro's number have been moved from Chapter 5 to Chapter 9 where they complement the material on quantitative composition of compounds.
- The sections on oxidation numbers and oxidation number tables have been moved from the end of Chapter 7 (Chemical Bonds) to the beginning of Chapter 8 (Nomenclature).

- The biochemistry section, especially Chapters 30 through 34, has been revised extensively.
- A chapter, Chapter 19, on the chemistry of some selected metals and non-metals has been added.
- Most of the end-of-chapter problems have been modified or are new.
- Both the joule and calorie are used as energy units, with emphasis on the joule.
- A more extensive discussion of enzymes has been added to Chapter 29.
- New material on viruses and genetic engineering has been introduced.
- The significance of processed foods, food additives, and dieting in relation to good nutrition is treated in more detail.
- A section on hydrolysis has been added to Chapter 16.
- Several pressure units are introduced in discussing the properties of gases, but emphasis is given to atmospheres and torrs in problems.
- A different method of balancing oxidation–reduction equations in alkaline solutions is given.
- Ionic bond is used in place of electrochemical bond.
- Much of the material on cell structure and function, formerly found in Chapter 30, has been integrated into Chapter 32, Bioenergetics.
- The use of K, L, M, . . . for atomic orbitals has been deleted.
- The periodic table most recently recommended by the American Chemical Society is shown in Appendix VI.

Acknowledgments

It is impossible to thank by name each of the many people who have been involved and helpful in making this revision of *College Chemistry*. We are grateful for the friendship and many helpful comments and suggestions from our colleagues and students who, over the years, have made this book possible. We appreciate the many helpful comments and suggestions made by the following reviewers of this manuscript: Robert Bruce Banks, *University of North Carolina, Greensboro*; Robert K. Boggess, *Radford University*; Edward J. Cowles, *University of Minnesota, Duluth*; David A. Darnall, *Shelby State Community College*; Karen E. Eichstadt, *Ohio University*; Edwin J. Gollier, *Virginia Military Institute*; John Pearsley, *Grossmont College*; and John K. Ruff, *University of Georgia*.

No textbook can be completed without the untiring effort of many professionals in publishing. Special thanks are due to Sue Ewing, Kath Minerva, Trisha Cain, Lisa Torri, and Flora Pomeroy of Brooks/Cole Publishing. All have contributed to making this edition.

Last, but certainly not least, we are grateful to our wives, Edna, Louise, and Joan, for their patience and understanding during this revision.

Morris Hein
Leo R. Best
Scott Pattison

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