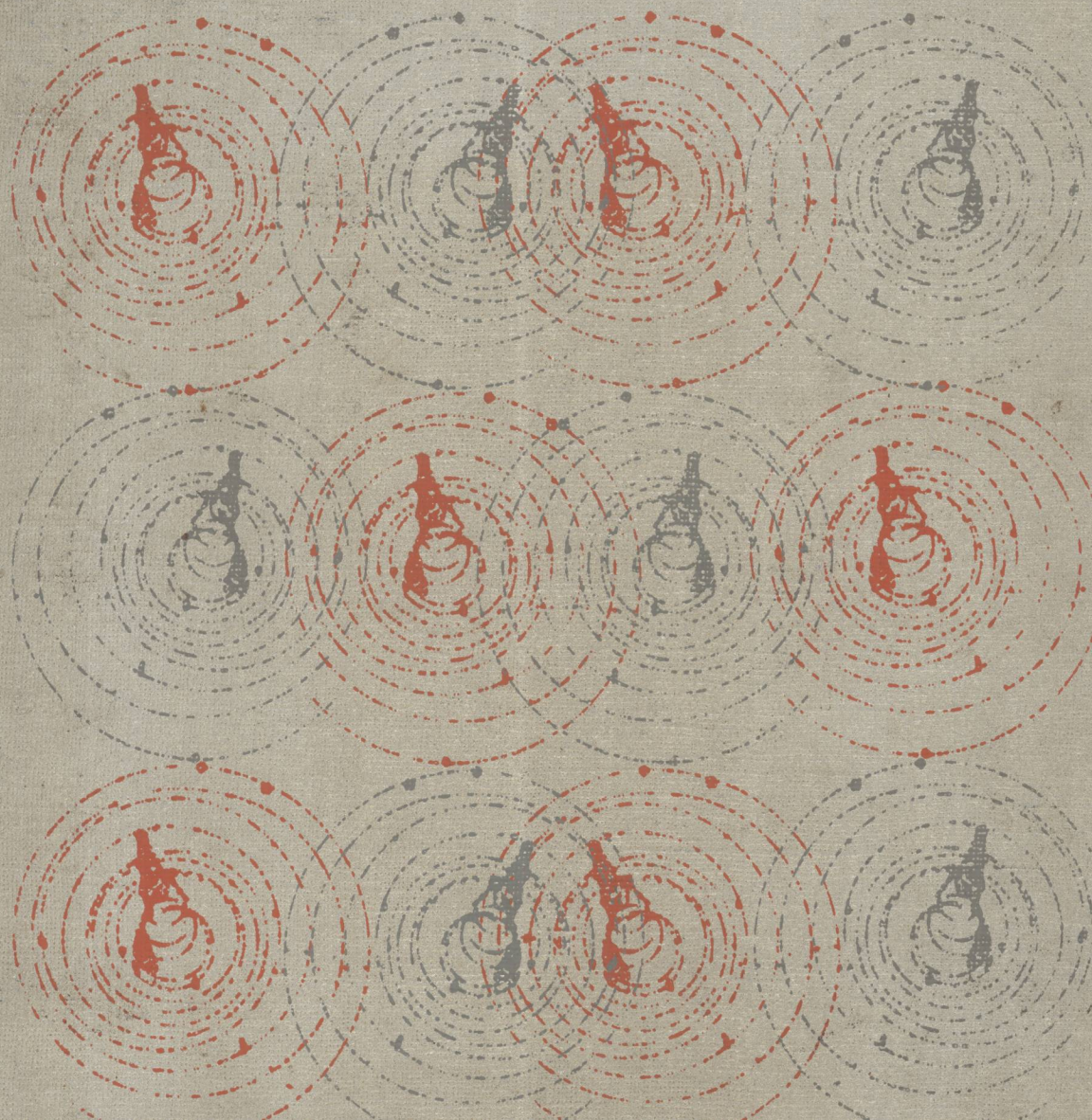


General College Chemistry

Earl S. Huyser



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General College Chemistry

EARL S. HUYSER
University of Kansas

D. C. HEATH AND COMPANY
Lexington, Massachusetts Toronto London



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Under the editorship of
Jacob Kleinberg
University of Kansas

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TABLE OF ATOMIC WEIGHTS, 1971 (Based on Carbon-12)

Values in parentheses are estimated and denote, in most cases, isotopes of longest half-life. Digits given as subscripts are reliable to $\pm 3\%$; other values are reliable to $\pm 1\%$ in the last digit.

SYMBOL	NO.	WEIGHT	SYMBOL	NO.	WEIGHT
Actinium	Ac	89 (227)	Mercury	Hg	80 200.5 ₉
Aluminum	Al	13 26.98154 ^a	Molybdenum	Mo	42 95.9 ₄
Americium	Am	95 (243)	Neodymium	Nd	60 144.2 ₄
Antimony	Sb	51 121.7 ₅	Neon	Ne	10 20.17 ₉ ^c
Argon	Ar	18 39.94 ₈ ^{b,c,d,g}	Neptunium	Np	93 237.0482 ^{b,f}
Arsenic	As	33 74.9216 ^a	Nickel	Ni	28 58.7 ₁
Astatine	At	85 (210)	Niobium	Nb	41 92.9064 ^a
Barium	Ba	56 137.3 ₄	Nitrogen	N	7 14.0067 ^{b,c}
Berkelium	Bk	97 (249)	Nobelium	No	102 (254)
Beryllium	Be	4 9.01218 ^a	Osmium	Os	76 190.2
Bismuth	Bi	83 208.9804 ^a	Oxygen	O	8 15.999 ₄ ^{b,c,d}
Boron	B	5 10.81 ^{c,d,e}	Palladium	Pd	46 106.4
Bromine	Br	35 79.904 ^c	Phosphorus	P	15 30.97376 ^a
Cadmium	Cd	48 112.40	Platinum	Pt	78 195.0 ₉
Calcium	Ca	20 40.08	Plutonium	Pu	94 (242)
Californium	Cf	98 (249)	Polonium	Po	84 (210)
Carbon	C	6 12.011 ^{b,d}	Potassium	K	19 39.09 ₈
Cerium	Ce	58 140.12	Praseodymium	Pr	59 140.9077 ^a
Cesium	Cs	55 132.9054 ^a	Promethium	Pm	61 (145)
Chlorine	Cl	17 35.453 ^c	Protactinium	Pa	91 231.0359 ^{a,f}
Chromium	Cr	24 51.996 ^c	Radium	Ra	88 226.0254 ^{a,f,g}
Cobalt	Co	27 58.9332 ^a	Radon	Rn	86 (222)
Copper	Cu	29 63.54 ₆ ^{c,d}	Rhenium	Re	75 186.2
Curium	Cm	96 (245)	Rhodium	Rh	45 102.9055 ^a
Dysprosium	Dy	66 162.5 ₀	Rubidium	Rb	37 85.467 ₈ ^c
Einsteinium	Es	99 (253)	Ruthenium	Ru	44 101.0 ₇
Erbium	Er	68 167.2 ₆	Rutherfordium	Rf	104 (257)
Europium	Eu	63 151.96	Samarium	Sm	62 150.4
Fermium	Fm	100 (254)	Scandium	Sc	21 44.9559 ^a
Fluorine	F	9 18.99840 ^a	Selenium	Se	34 78.9 ₆
Francium	Fr	87 (223)	Silicon	Si	14 28.08 ₆ ^d
Gadolinium	Gd	64 157.2 ₅	Silver	Ag	47 107.868 ^c
Gallium	Ga	31 69.72	Sodium	Na	11 22.98977 ^a
Germanium	Ge	32 72.5 ₉	Strontium	Sr	38 87.62 ^f
Gold	Au	79 196.9665 ^a	Sulfur	S	16 32.06 ^d
Hafnium	Hf	72 178.4 ₉	Tantalum	Ta	73 180.947 ₉ ^b
Hahnium	Ha	105 (260)	Technetium	Tc	43 98.9062 ^f
Helium	He	2 4.00260 ^{b,c}	Tellurium	Te	52 127.6 ₀
Holmium	Ho	67 164.9304 ^a	Terbium	Tb	65 158.9254 ^a
Hydrogen	H	1 1.0080 ^{b,d}	Thallium	Tl	81 204.3 ₇
Indium	In	49 114.82	Thorium	Th	90 232.0381 ^{a,f}
Iodine	I	53 126.9045 ^a	Thulium	Tm	69 168.9342 ^a
Iridium	Ir	77 192.2 ₂	Tin	Sn	50 118.6 ₉
Iron	Fe	26 55.84 ₇	Titanium	Ti	22 47.9 ₀
Krypton	Kr	36 83.80	Tungsten	W	74 183.8 ₅
Lanthanum	La	57 138.905 ₅ ^b	Uranium	U	92 238.029 ^{b,c,e}
Lawrencium	Lr	103 (257)	Vanadium	V	23 50.941 ₄ ^{b,c}
Lead	Pb	82 207.2 ^{d,g}	Xenon	Xe	54 131.30
Lithium	Li	3 6.94 ₁ ^{c,d,e}	Ytterbium	Yb	70 173.0 ₄
Lutetium	Lu	71 174.97	Yttrium	Y	39 88.9059 ^a
Magnesium	Mg	12 24.305 ^c	Zinc	Zn	30 65.38
Manganese	Mn	25 54.9380 ^a	Zirconium	Zr	40 91.22
Mendelevium	Md	101 (256)			

^a Mononuclidic element.
^b Element with one predominant isotope (about 99–100 per cent abundance).
^c Element for which the atomic weight is based on calibrated measurements.
^d Element for which variation in isotopic abundance in terrestrial samples limits the precision of the atomic weight given.
^e Element for which users are cautioned against the possibility of large variations in atomic weight due to inadvertent or undisclosed artificial isotopic separation in commercially available materials.
^f Most commonly available long-lived isotope.
^g In some geological specimens this element has a highly anomalous isotopic composition corresponding to an atomic weight significantly different from that given.
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METALS

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* LANTHANIDE
SERIES

† ACTINIDE
SERIES

138.91	140.12	140.907	144.24	(145)	150.35	151.96	157.25	158.924	162.50	164.930	167.26	168.934	173.04	174.97
La[57]	Ce[58]	Pr[59]	Nd[60]	Pm[61]	Sm[62]	Eu[63]	Gd[64]	Tb[65]	Dy[66]	Ho[67]	Er[68]	Tm[69]	Yb[70]	Lu[71]
18, 9, 2	20, 8, 2	21, 8, 2	22, 8, 2	23, 8, 2	24, 8, 2	25, 8, 2	25, 9, 2	27, 8, 2	28, 8, 2	29, 8, 2	30, 8, 2	31, 8, 2	32, 8, 2	32, 9, 2
(227)	232.038	(231)	238.03	(237)	(242)	(243)	(245)	(245)	(248)	(253)	(254)	(256)	(253)	(257)
Ac[68]	Th[90]	Pa[91]	U[92]	Np[93]	Pu[94]	Am[95]	Cm[96]	Bk[97]	Cf[98]	Es[99]	Fm[100]	Md[101]	No[102]	Lw[103]
18, 9, 2	18, 10, 2	20, 9, 2	21, 9, 2	23, 8, 2	24, 8, 2	25, 8, 2	25, 9, 2	26, 9, 2	28, 8, 2	29, 8, 2	30, 8, 2	31, 8, 2	32, 8, 2	32, 9, 2

General College Chemistry

Preface

General College Chemistry was written for those college students whose major interests are in areas other than chemistry. For many in this group a chemistry course is still required for their particular programs (for example, home economics, many engineering disciplines, nursing, and the several allied health programs). For others of the group a chemistry course fulfills a science requirement for a degree; for still others the course may simply satisfy a desire to become acquainted with chemistry.

The various needs that must be met for those who will use this text have been kept in mind by the author and editors throughout its entire preparation. We trust that our concern is reflected both in the subject matter included and in the manner of its presentation.

Four general areas of chemistry are covered in the book. The first of these (Chapters 1–8) is for the purpose of providing the student with an understanding of some important principles of chemistry, more specifically those related to atomic and molecular structure, stoichiometry and chemical reactions, and the physical properties of matter in terms of the kinetic molecular theory of matter. The general topic of the second of the areas covered (Chapters 9–15) is elementary organic chemistry. Although the material here is largely descriptive, it is based on the principles developed in the earlier chapters. The portion of the book dealing with biochemistry (Chapters 16–19) includes material on some of the kinds of substances (sugars, amino acids, proteins, nucleotides, and nucleic acids) encountered in living organisms, as well as on some of the more important biochemical reactions (for example, oxidative metabolism and biosynthetic processes such as photosynthesis). The details of these reactions are given in Appendices 2–8. Several nonorganic topics are covered in the remainder of the text (Chapters 20–25). Among these are electrochemistry, nuclear chemistry, and the chemistry of some of the more important metallic and nonmetallic elements.

General College Chemistry is organized and presented in a manner that allows for substantial flexibility in its use as a text. It can be used for either a two-semester (three-quarter) course or a one-semester (two-quarter) course. For a two-semester course the material may be presented in the order that exists in the book. In this case, some of the organic chemistry will be taught in the first semester. If, however, an emphasis on nonorganic chemistry is desired early in the two-semester sequence, it is possible to skip from Chapter 8 (or for that matter, Chapter 6) to Chapter 20 without any loss of conti-

nuity. The organic and biochemistry material would then constitute the major part of the second semester. A one-semester course would include the basic concepts found in the first part of the book (particularly in Chapters 2–6) and would be followed by selected portions of the remainder of the book. (Suggested choices of material for one-semester courses with different emphases are outlined in the instructor's manual.)

Throughout the book the interrelationships are shown between chemistry and topics in areas such as history, economics, sociology, ecology and environmental concerns, and matters related to energy. The discussions relating chemistry to such topics are not relegated to special parts of the book but are always presented in the framework of the chemical principles under consideration. This manner of presentation was adopted to assure attainment of the goal of making *General College Chemistry* a *chemistry* textbook and not a book that merely tells about some of the interesting aspects of chemistry.

At the beginning of each chapter there is a *Note to the Student* and at the end of each chapter a list of *Key Terms and Concepts*. The note to the student is not an "abstract." Rather, it is a statement designed to prepare the student for what he or she will encounter in the chapter. The list of key terms and concepts is not exhaustive, being limited to only those items that pertain to the *significant* chemistry developed in the chapter. These two features are included primarily as aids to the student. Exercises are also given at the end of each chapter and are so designed as to be of maximum value to the student. Each exercise is directed toward a further understanding of an important concept developed in the chapter. Exercises of a numerical nature are based on the problems (with solutions) that were used in the chapter to demonstrate the quantitative aspects of chemical principles, and do not in any way test mathematical skills. Every attempt has been made to provide exercises of such a nature that the student's study does not become a frustrating experience with numerical problems. Answers are provided for all exercises that involve numerical calculations.

The author has been helped by a number of people in many ways in the preparation of this book. He not only wishes to acknowledge their efforts but also to express his sincere appreciation for their counsel and encouragement. The original manuscript was reviewed by Professors William T. Mooney, Jr., El Camino College; John W. Coutts, Lake Forest College; John T. Healey, Chabot College; Allan Cunningham, Monterey Peninsula College; H. LeRoy Nyquist, California State University (Northridge); and Reverend John R. Trzaska, Boston College. The comments and constructive criticisms of these reviewers were invaluable, and many of their suggested alterations were incorporated in the final manuscript. The author also owes a debt of gratitude to Professor David Paretsky, University of Kansas, for his aid in the preparation of the material related to biochemistry. The assistance of Mrs. Nancy Murray in the typing of the manuscript was of no small significance and is gratefully acknowledged.

A special debt of gratitude is owed to the author's colleague and friend, Professor Jacob Kleinberg, who served as the consulting editor for this book. Professor Kleinberg was actively involved in every stage of the development of this book, offering counsel in matters relating to organization of material,

writing, and scientific accuracy. Finally, the author wishes to express his thanks to Dr. Paul Bryant of D. C. Heath and Company who played a most significant role in transforming a manuscript into a book. He made this phase of the project not only an education to the author but also a pleasant experience.

Earl S. Huyser
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