COLLEGE CHEMISTRY

J. Nelson Shaw

7962946

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J. Nelson Shaw
San Francisco State College

E7962946

CHARLES E. MERRILL BOOKS, INC., COLUMBUS, OHIO

To

RICHARD E. CARRIER

For a friendship that has given me great pleasure

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INTERNATIONAL ATOMIC WEIGHTS

Element	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	39.948
Arsenic	As	33	74.92
Astatine	At	85	[210] *
Barium	Ba	56	137.34
Berkelium	Bk	97	[249] *
Beryllium	Be	4	9.012
Bismuth	Bi	83	208.98
Boron	B	5	10.81
Bromine	Br	35	79.909
Cadmium	Cd	48	112.40
Calcium	Ca	20	40.08
Californium	Cf	98	[251] *
Carbon	C	6	12.011
Cerium	Ce	58	140.12
Cesium	Cs	55	132.91
Chlorine	Cl	17	35.453
Chromium	Cr	24	52.00
Cobalt	Co	27	58.93
Copper	Cu	29	63.54
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	[253] *
Fluorine	F	9	18.998
Francium	Fr	87	[223] *
Gadolinium	Gd	64	157.25
Gallium	Ga	31	69.72
Germanium	Ge	32	72.59
Gold	Au	79	197.0
Hafnium	Hf	72	178.49
Helium	He	2	4.003
Holmium	Ho	67	164.93
Hydrogen	H	1	1.0080
Indium	In	49	114.82
Iodine	I	53	126.90
Iridium	Ir	77	192.2
Iron	Fe	26	55.85
Krypton	Kr	36	83.80
Lanthanum	La	57	138.91
Lawrencium	Lw	103	[257] *
Lead	Pb	82	207.19
Lithium	Li	3	6.939
Lutetium	Lu	71	174.97
Magnesium	Mg	12	24.31
Manganese	Mn	25	54.94
Mendelevium	Md	101	[256] *
Mercury	Hg	80	200.59
Molybdenum	Mo	42	95.94
Neodymium	Nd	60	144.24
Neon	Ne	10	20.183
Neptunium	Np	93	[237] *
Nickel	Ni	28	58.71
Niobium	Nb	41	92.91
Nitrogen	N	7	14.007
Nobelium	No	102	[254] *
Osmium	Os	76	190.2
Oxygen	O	8	15.994
Palladium	Pd	46	106.4
Phosphorus	P	15	30.974
Platinum	Pt	78	195.09
Plutonium	Pu	94	[242] *
Polonium	Po	84	[210] *
Potassium	K	19	39.102
Praseodymium	Pr	59	140.91
Promethium	Pm	61	[147] *
Protactinium	Pa	91	[231] *
Radium	Ra	88	226.05
Radon	Rn	86	[222] *
Rhenium	Re	75	186.21
Rhodium	Rh	45	102.90
Rubidium	Rb	37	85.47
Ruthenium	Ru	44	101.1
Samarium	Sm	62	150.35
Scandium	Sc	21	44.96
Selenium	Se	34	78.96
Silicon	Si	14	28.09
Silver	Ag	47	107.870
Sodium	Na	11	22.990
Strontium	Sr	38	87.62
Sulfur	S	16	32.064
Tantalum	Ta	73	180.95
Technetium	Tc	43	[99] *
Tellurium	Te	52	127.60
Terbium	Tb	65	158.92
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†	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	65.37
Zirconium	Zr	40	91.22

* A VALUE IN BRACKETS [ ] DENOTES THE MASS NUMBER OF THE ISOTOPE WITH THE LONGEST KNOWN HALF-LIFE.

† ALSO CALLED WOLFRAM.

PERIODIC CLASSIFICATION OF THE ELEMENTS

(BASED ON $C^{12} = 12.0000$)

1961 ATOMIC WEIGHTS

Light Metals — Heavy Metals — Nonmetals

IA	IIA	IIIB	IVB	VB	VIB	VIIB	VIIIB		IB	IIB	IIIA	IVA	VA	VIA	VIIA	VIIIA
1 H 1.0080																2 He 4.003
3 Li 6.939	4 Be 9.012										5 B 10.81	6 C 12.011	7 N 14.007	8 O 15.9994	9 F 18.998	10 Ne 20.183
11 Na 22.990	12 Mg 24.31										13 Al 26.98	14 Si 28.09	15 P 30.974	16 S 32.064	17 Cl 35.453	18 Ar 39.948
19 K 39.102	20 Ca 40.08	21 Sc 44.96	22 Ti 47.90	23 V 50.94	24 Cr 52.00	25 Mn 54.94	26 Fe 55.85	27 Co 58.93	28 Ni 58.71	29 Cu 63.54	30 Zn 65.37	31 Ga 69.72	32 Ge 72.59	33 As 74.92	34 Se 78.96	35 Br 79.909	36 Kr 83.80
37 Rb 85.47	38 Sr 87.62	39 Y 88.91	40 Zr 91.22	41 Nb 92.91	42 Mo 95.94	43 Tc (99)	44 Ru 101.1	45 Rh 102.90	46 Pd 106.4	47 Ag 107.870	48 Cd 112.40	49 In 114.82	50 Sn 118.69	51 Sb 121.75	52 Te 127.60	53 I 126.90	54 Xe 131.30
55 Cs 132.91	56 Ba 137.34	57 TO 71	72 Hf 178.49	73 Ta 180.95	74 W 183.85	75 Re 186.2	76 Os 190.2	77 Ir 192.2	78 Pt 195.09	79 Au 197.0	80 Hg 200.59	81 Tl 204.37	82 Pb 207.19	83 Bi 208.98	84 Po (210)	85 At (210)	86 Rn (222)
87 Fr (223)	88 Ra 226.05	89 TO 103															

Lanthanide series	57 La 138.91	58 Ce 140.12	59 Pr 140.91	60 Nd 144.24	61 Pm (147)	62 Sm 150.35	63 Eu 151.96	64 Gd 157.25	65 Tb 158.92	66 Dy 162.50	67 Ho 164.93	68 Er 167.26	69 Tm 168.93	70 Yb 173.04	71 Lu 174.97
Actinide series	89 Ac (227)	90 Th 232.04	91 Pa (231)	92 U 238.03	93 Np (237)	94 Pu (242)	95 Am (243)	96 Cm (247)	97 Bk (249)	98 Cf (251)	99 Es (254)	100 Fm (253)	101 Md (256)	102 No (254)	103 Lw (257)

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COLLEGE CHEMISTRY

Chemistry—Study and teaching
(Higher)

The Merrill Physical and Inorganic Chemistry Series

Theodore L. Brown, Editor
University of Illinois

PREFACE

The aim of *College Chemistry* is to present the basic concepts involved in the study of chemistry in a way that will enable a student to correlate some of the vast amount of chemical information. The emphasis on fundamental concepts gives a student experience with the methods and logic of chemistry. Descriptive chemistry is used to exemplify and introduce concepts. This integration of descriptive chemistry at appropriate points promotes the view that empirical observations are neither apart from nor independent of theoretical discussion.

The presentation of modern chemistry to students who have had a previous course in chemistry has been done well by other people. *College Chemistry* assumes no such experience. It is written for students in any of three broad types of courses: (1) A terminal course for non-science majors; (2) A one-semester preparatory course for those students who intend to move into a course specifically for science majors; (3) A one-year course in which both science and non-science majors are enrolled.

The task of preparing the science majors for additional courses in chemistry while giving the non-science majors some understanding and appreciation of chemistry is a difficult one. *College Chemistry* is designed to help remove some of this difficulty. The more advanced topics such as thermodynamics, kinetics, activities, and electrochemistry are presented in a manner simple enough that non-science majors can grasp the concepts. At the discretion of the instructor the concepts may then be applied, or

extended readily to the depth necessary, for any particular group of students. As an example, molecular geometry is explained in terms of electron-pair repulsion. This seems reasonable for any student with even a slight knowledge of simple electrostatics. The additional or alternative explanation in the terms of hybridization of orbitals, though more abstract, can be comprehended after sufficient discussion.

In the interest of allowing the instructor to tailor the book to his course, the later chapters—particularly those after Chapter 8—are relatively self-contained. Although the presentation of topics does not presuppose a course in high school chemistry, it does depend on some knowledge of basic algebra.

For electrochemical processes the IUPAC convention has been used for the standard electrode potentials, and qualitative use has been made of the Nernst equation.

The appendices have been designed to allow for the extension of text material. For example, comparatively extensive tables of data are available for the writing of additional problems by the instructor. These data are, of course, readily accessible to the student. The description of many industrial processes and laboratory syntheses should provide a source of additional descriptive chemistry.

I gratefully acknowledge the encouragement and patience of the Merrill staff, especially Pat Hearne. I also want to acknowledge the truly incomparable assistance of Ruth Green, who put in the long hours necessary to type the manuscript.

In the interest of future printings and editions, I should greatly appreciate any notices of error and suggestions for changes.

San Francisco
February, 1966

J. Nelson Shaw

PERIODIC CLASSIFICATION OF THE ELEMENTS

(BASED ON $C^{12} = 12.0000$)

1961 ATOMIC WEIGHTS

Light Metals

Heavy Metals

I A	II A	III B	IV B	V B	VI B	VII B	VIII B		
1 **H** 1.0080									
3 **Li** 6.939	4 **Be** 9.012								
11 **Na** 22.990	12 **Mg** 24.31								
19 **K** 39.102	20 **Ca** 40.08	21 **Sc** 44.96	22 **Ti** 47.90	23 **V** 50.94	24 **Cr** 52.00	25 **Mn** 54.94	26 **Fe** 55.85	27 **Co** 58.93	28 **Ni** 58.71
37 **Rb** 85.47	38 **Sr** 87.62	39 **Y** 88.91	40 **Zr** 91.22	41 **Nb** 92.91	42 **Mo** 95.94	43 **Tc** (99)	44 **Ru** 101.1	45 **Rh** 102.90	46 **Pd** 106.4
55 **Cs** 132.91	56 **Ba** 137.34	57 TO 71	72 **Hf** 178.49	73 **Ta** 180.95	74 **W** 183.85	75 **Re** 186.2	76 **Os** 190.2	77 **Ir** 192.2	78 **Pt** 195.09
87 **Fr** (223)	88 **Ra** 226.05	89 TO 103							

Lanthanide series	57 **La** 138.91	58 **Ce** 140.12	59 **Pr** 140.91	60 **Nd** 144.24	61 **Pm** (147)	62 **Sm** 150.35
Actinide series	89 **Ac** (227)	90 **Th** 232.04	91 **Pa** (231)	92 **U** 238.03	93 **Np** (237)	94 **Pu** (242)

							VIII A
		Nonmetals					2 **He** 4.003
		III A	IV A	V A	VI A	VII A	
		5 **B** 10.81	6 **C** 12.011	7 **N** 14.007	8 **O** 15.9994	9 **F** 18.998	10 **Ne** 20.183
I B	II B	13 **Al** 26.98	14 **Si** 28.09	15 **P** 30.974	16 **S** 32.064	17 **Cl** 35.453	18 **Ar** 39.948
29 **Cu** 63.54	30 **Zn** 65.37	31 **Ga** 69.72	32 **Ge** 72.59	33 **As** 74.92	34 **Se** 78.96	35 **Br** 79.909	36 **Kr** 83.80
47 **Ag** 107.870	48 **Cd** 112.40	49 **In** 114.82	50 **Sn** 118.69	51 **Sb** 121.75	52 **Te** 127.60	53 **I** 126.90	54 **Xe** 131.30
79 **Au** 197.0	80 **Hg** 200.59	81 **Tl** 204.37	82 **Pb** 207.19	83 **Bi** 208.98	84 **Po** (210)	85 **At** (210)	86 **Rn** (222)

63 **Eu** 151.96	64 **Gd** 157.25	65 **Tb** 158.92	66 **Dy** 162.50	67 **Ho** 164.93	68 **Er** 167.26	69 **Tm** 168.93	70 **Yb** 173.04	71 **Lu** 174.97
95 **Am** (243)	96 **Cm** (247)	97 **Bk** (249)	98 **Cf** (251)	99 **Es** (254)	100 **Fm** (253)	101 **Md** (256)	102 **No** (254)	103 **Lw** (257)

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