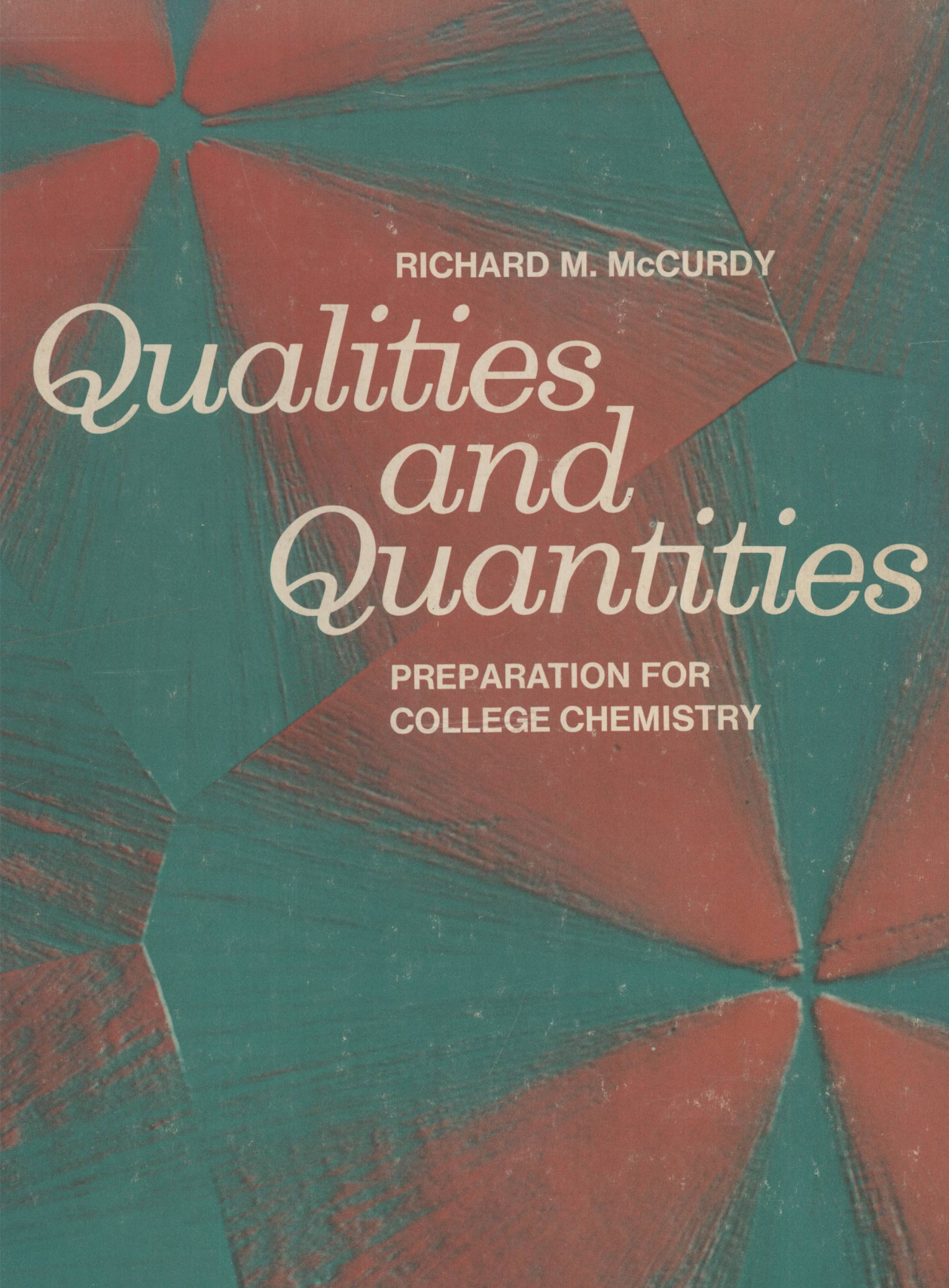
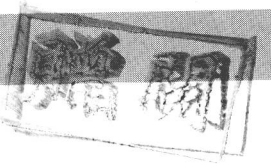

RICHARD M. McCURDY
Qualities and Quantities
PREPARATION FOR COLLEGE CHEMISTRY



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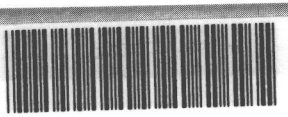

PREPARATION FOR COLLEGE CHEMISTRY

RICHARD M. McCURDY
Los Angeles Pierce College

HARCOURT BRACE JOVANOVICH, INC.
NEW YORK CHICAGO SAN FRANCISCO ATLANTA

To my teachers
and
To my students,
especially
Danny H.
who lives in this book

Qualities and Quantities: Preparation for College Chemistry

Photo credits appear on page 316.

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( ) indicates the most stable or best-known isotope.

	Symbol	Atomic Number	Atomic Weight
Actinium	Ac	89	(227)
Aluminum	Al	13	26.9815
Americium	Am	95	(243)
Antimony	Sb	51	121.75
Argon	Ar	18	39.948
Arsenic	As	33	74.9216
Astatine	At	85	(210)
Barium	Ba	56	137.34
Berkelium	Bk	97	(247)
Beryllium	Be	4	9.01218
Bismuth	Bi	83	208.9804
Boron	B	5	10.81
Bromine	Br	35	79.904
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	132.9054
Chlorine	Cl	17	35.453
Chromium	Cr	24	51.996
Cobalt	Co	27	58.9332
Copper	Cu	29	63.546
Curium	Cm	96	(247)
Dysprosium	Dy	66	162.50
Einsteinium	Es	99	(254)

	Symbol	Atomic Number	Atomic Weight
Erbium	Er	68	167.26
Europium	Eu	63	151.96
Fermium	Fm	100	(257)
Fluorine	F	9	18.99840
Francium	Fr	87	(223)
Gadolinium	Gd	64	157.25
Gallium	Ga	31	69.72
Germanium	Ge	32	72.59
Gold	Au	79	196.9665
Hafnium	Hf	72	178.49
Helium	He	2	4.00260
Holmium	Ho	67	164.9304
Hydrogen	H	1	1.0079
Indium	In	49	114.82
Iodine	I	53	126.9045
Iridium	Ir	77	192.22
Iron	Fe	26	55.847
Krypton	Kr	36	83.80
Lanthanum	La	57	138.9055
Lawrencium	Lr	103	(256)
Lead	Pb	82	207.2
Lithium	Li	3	6.941
Lutetium	Lu	71	174.97
Magnesium	Mg	12	24.305
Manganese	Mn	25	54.9380
Mendelevium	Md	101	(258)

Table of Atomic Weights BASED ON CARBON-12

	Symbol	Atomic Number	Atomic Weight
Mercury	Hg	80	200.59
Molybdenum	Mo	42	95.94
Neodymium	Nd	60	144.24
Neon	Ne	10	20.179
Neptunium	Np	93	237.0482
Nickel	Ni	28	58.70
Niobium	Nb	41	92.9064
Nitrogen	N	7	14.0067
Nobelium	No	102	(255)
Osmium	Os	76	190.2
Oxygen	O	8	15.9994
Palladium	Pd	46	106.4
Phosphorus	P	15	30.9738
Platinum	Pt	78	195.09
Plutonium	Pu	94	(244)
Polonium	Po	84	(210)
Potassium	K	19	39.098
Praseodymium	Pr	59	140.9077
Promethium	Pm	61	(147)
Protactinium	Pa	91	231.0359
Radium	Ra	88	226.0254
Radon	Rn	86	(222)
Rhenium	Re	75	186.207
Rhodium	Rh	45	102.9055
Rubidium	Rb	37	85.4678
Ruthenium	Ru	44	101.07
Samarium	Sm	62	150.4
Scandium	Sc	21	44.9559
Selenium	Se	34	78.96
Silicon	Si	14	28.086
Silver	Ag	47	107.868
Sodium	Na	11	22.9898
Strontium	Sr	38	87.62
Sulfur	S	16	32.06
Tantalum	Ta	73	180.9479
Technetium	Tc	43	98.9062
Tellurium	Te	52	127.60
Terbium	Tb	65	158.9254
Thallium	Tl	81	204.37
Thorium	Th	90	232.0381
Thulium	Tm	69	168.9342
Tin	Sn	50	118.69
Titanium	Ti	22	47.90
Tungsten	W	74	183.85
Uranium	U	92	238.029
Vanadium	V	23	50.9414
Xenon	Xe	54	131.30
Ytterbium	Yb	70	173.04
Yttrium	Y	39	88.9059
Zinc	Zn	30	65.38
Zirconium	Zr	40	91.22

Qualities and

to the instructor

This book is intended to serve as a preparative text for students who require one or more years of college chemistry, but who have either never had high school chemistry or have forgotten it.

I believe that the average student must bring the following knowledge and skills to the modern general chemistry course:

1. computational skills involving mass, volume, density, and percent composition;
2. understanding of applications of the ideal gas law;
3. sufficient knowledge of atomic structure to recognize the origins and meaning of bonding and molecular structure;
4. familiarity with the nomenclature of common inorganic substances;
5. knowledge of equation writing and balancing;
6. ability to perform weight/weight and weight/volume computations from equations and solution stoichiometry;
7. knowledge of the various categories of chemical reactions; and
8. some knowledge of the physics of energy transformations.

Students with a sound grasp of these concepts and skills can then benefit from a meaningful treatment of atomic and molecular structure, thermodynamics, chemical equilibrium, complex-ion bonding, and nuclear chemistry in a subsequent course.

The organization of this book enables students with no prior mathematical preparation except arithemtic to solve chemical problems successfully. The problem-solving method is used consistently throughout the text. The method emphasizes those properties that can be measured and the linear relationships that exist between them. Half the problems in each set are answered in factored form, so students can check the method as well as the answers.

The gas laws and composition are presented early because they provide immediate applications on which students can test their problem-solving skills. Students usually have no difficulty accepting the idea of atoms as particles in motion that may occur in certain number combinations. The derivation of kinetic molecular theory is valuable for the quantitative picture it gives of the effects of temperature, pressure, and numbers of molecules, but it is not necessary for continuity and may be omitted. The early introduction of the gas laws and

composition has an added benefit in that it provides the subject matter for relevant laboratory experience.

In deference to those who prefer a different order of presentation, there is sufficient overlap in Chapters Four through Eight for atomic structure or composition to be introduced first.

The last six chapters, in addition to providing considerable drill in computational skills, present some intuitive ideas of thermodynamics and reaction mechanisms so that the student will have some basis for understanding the quantitative treatment in subsequent courses.

Although the contents of this text is solely my responsibility, I gratefully acknowledge that the final form is the product of thoughtful consideration by many fine educators. I would like to note especially the contributions of Frances Collins, University of Massachusetts at Amherst; Edward C. Fohn, Green River Community College; Melvin W. Hanna, University of Colorado; John J. Healey, Chabot College; James MacDonald, DeAnza College; and Michael J. Millam, Phoenix College. I also feel exceptionally fortunate to have had the experience of working with the highly professional editorial, design, and production staff of Harcourt Brace Jovanovich, Inc.

RICHARD M. McCURDY

to the student

This book was written primarily to help you learn chemistry. You may find that the skills and attitudes you develop will be useful in other fields as well. The basic concepts of chemistry are easy to understand, and their application to the solution of problems in chemical arithmetic is even easier. The amount of study and practice required depends on how efficiently you work.

Your efficiency will improve if you learn to use words precisely. Always be able to reply with an exact answer to the questions, "What am I doing?" and "What do I want to know?" For example, saying you are flying a kite is not being exact; you are really holding a string.

Develop your awareness of the relationships that exist between one observable fact and another. You know that if you hold the string so that the kite is at a certain angle with the wind it will fly. So you are expressing the *result* of your action, rather than the action itself. Not knowing the relationship could result in your holding the string unsuccessfully all day.

In a similar way the scientist who measures the temperature of the contents of a reaction vessel knows that what is really being measured is the volume of the column of mercury in a thermometer compared to the volume at some reference temperature. Knowing this, the scientist can be aware of the possibilities of error. The manufacturer may not have put the right amount of mercury in the thermometer, or the scale could be wrong. The scientist who knows the relationship between what is being measured and what is wanted can check to see if it is satisfied.

You can succeed in chemistry by (1) labeling things for what they are; (2) learning the relationships that exist between physical quantities; and (3) using the relationships to find the desired result from the given data. The frosting on the cake, though, is knowing why these things are true and why they work. The explanations, insofar as we know them, are presented in this book in a nonmathematical form. Additional references are provided at the end of some chapters for those of you who wish to explore any of these topics in greater depth.

Above all, be thoughtful. Be critical. Test every new idea to see if it is true within your experience.

RICHARD M. McCURDY

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Qualities and Quantities

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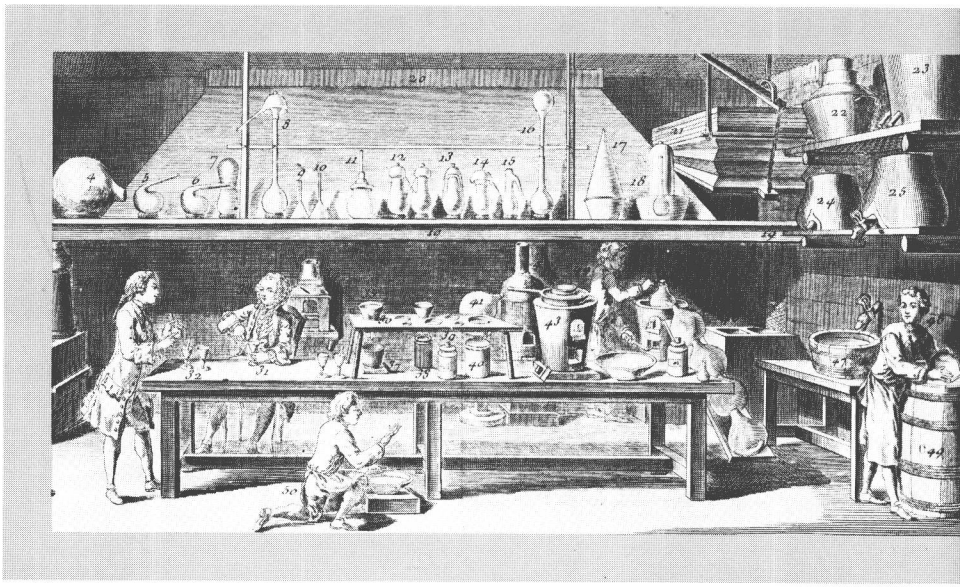
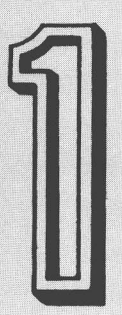


"Science is the attempt to make the chaotic diversity of our sense-experience correspond to a logically uniform system of thought." (Albert Einstein, *Science, 91,* 1940)

After reading this chapter you should be aware of

1. The ways in which science differs from other branches of human knowledge;
2. The meaning of a scientific law;
3. The difference between empirical laws and fundamental laws;
4. How theories are formed from hypotheses and laws;
5. The meaning and uses of experiments;
6. The meaning of technology;
7. The role of chemistry in science and technology;
8. The reasons more scientific research is necessary in order to prevent ecological disaster.

introduction



What is science? 1.0

Science has been called many names, some of them downright uncomplimentary. What is there about this abstract noun that people fear and worship?

According to Webster's, *science* is

1. *knowledge* gained by *study* and *practice.*
2. any department of *systematized* knowledge.
3. a branch of study concerned with the *observation* and *classification* of facts, especially with the establishment of *verifiable general laws*....
4. specific accumulated knowledge, systematized and formulated with reference to the *discovery* of general *truths* or the operation of general laws.

That looks pretty formidable. No wonder people are afraid of it. Before you decide that science has nothing for you, let us look at the key words in that definition to see what deeper meaning they might have.