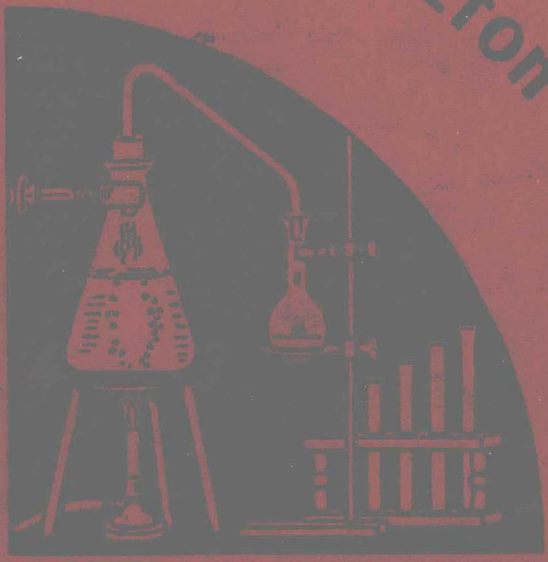
MODERN-LIFE CHEMISTRY

KRUH · CARLETON · CARPENTER



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Courtesy Electro Metallurgical Company

Stainless steel rails such as grace the lobby of this theater are products of modern-life chemistry.

PREFACE FOR THE TEACHER

Courses in high school science are undergoing changes which, to some teachers, seem to be more revolution than evolution. But fore-thinkers in the field of science teaching, as well as research studies pertaining to related problems, offer convincing arguments and evidence that this "new" kind of science is desirable, because it is based upon an adequate philosophy of education and involves a sound psychology of learning. The majority of present-day courses in general science and biology are organized according to the newer point of view, as evidenced by textbooks and courses of study, but the physical sciences have been slow to respond.

Modern-Life Chemistry is offered in the belief that it will prove to be a positive contribution to the evolution of a truly functional chemistry course for high school students. The enthusiastic reception given a previous similar publication of two of the authors [1] implies that teachers of chemistry are ready for such a textbook, and provided much encouragement during the time that this book was in preparation.

The authors accept the philosophy that high school chemistry should function so as to modify human behavior in a desirable way, both in its individual and social aspects. It should not be taught merely for the sake of chemistry, but for the sake of the learner. In this connection, we quote Dr. Robert A. Millikan: "We need science in education not primarily to train technicians for the industries, but to give everybody a little glimpse of the scientific mode of approach to life's problems and to give everybody some familiarity with at least one field in which the distinction between correct and incorrect is not always blurred and uncertain, and that one opinion is as good as another." [2]

1 Carpenter, F. F., and Carleton, R. H., *Comprehensive Units in Chemistry*. J. B. Lippincott Co., 1935.

2 *Science Leaflet:* 10, VIII, Mar. 14, 1936, State College, Penn.

In order to accomplish this end, *knowledge* is essential. This includes a command of *fundamental facts,* and also an understanding of *basic ideas, principles,* and *generalizations.* It is a psychological fact that when the memory fails, the facts are gone, but that true insights or understandings remain with us practically forever. There is some evidence to indicate, however, that when instruction aims at the mastery of fundamental principles and generalizations, the supporting facts are more easily catalogued and are remembered longer.

In this textbook, certain basic ideas, principles, generalizations, and aspects of chemistry constitute the units of the course. To facilitate their study, the units are further divided into several parts, each of which centers around a logical subdivision of the unit and contributes to its central theme. The subject matter of chemistry is organized around these divisions, and has been carefully selected on the basis of (1) a study of existing textbooks of chemistry; (2) a study of recognized syllabi; (3) a study of the literature and research investigations pertinent to the subject; (4) a study of the popular "story books" of chemistry; and (5) the experience of the authors in teaching high school chemistry and other science.

If students are to be given predispositions *to do* things *better,* or *differently,* or *more intelligently* and with *greater understanding,* knowledge alone is not enough to assure attainment of this aim. Students must be trained in the use of the *scientific method.* This is largely dependent upon the techniques of instruction employed, but the organization of the materials of instruction is a very important contributory factor. For this reason, an adaptation of the Morrison unit-problem plan has been selected, and the divisions of the units have been organized as "Problems to Be Solved." This plan needs no lengthy justification here, for it is now accepted almost universally and its basic advantages are well known. Recognition of problems and the procedures necessary for their solution constitute training in the use of the scientific method.

The following outline presents the plan of organization used for each unit in *Modern-Life Chemistry:*

I. The Unit Assignment
   A. Defining the unit
   B. Unit problems to be solved

II. Assimilative Material for the Unit
   A. Solving Problem 1 of the unit
      1. Problem assignment
      2. Presentation of subject matter of the problem
      3. Problem summary exercises that everyone should do
   B. Solving Problem 2 of the unit
      1. Problem assignment
      2. Presentation of subject matter of the problem
      3. Problem summary exercises that everyone should do
   C. Solving Problem 3 of the unit

III. Optional Material for the Unit
   A. Additional problem summary exercises
   B. Exercises in chemical arithmetic
   C. Topics for investigation and reports

IV. Unit Recitation and Test: Topics for oral or written recitation

The following tested techniques and devices that stimulate interest and facilitate learning have been incorporated into this text.

(1) Each unit is introduced by means of a concise assignment which clearly defines the central idea to be mastered in the unit. Each problem begins with an assignment which explains its purpose. The first step in meeting any assignment is to know what the assignment is; that is the purpose of the unit and problem assignments.

(2) Illustrations and drawings were chosen with the intention of clarifying the materials under discussion and assisting students to understand the applications of chemical knowledge.

(3) In an effort to portray the scientific method and the scientific attitude, portraits and biographical accounts of emi-

nent chemists are appropriately included, often with a text discussion of their investigations and contributions.

(4) The fundamental theories, laws, and "tools" of chemistry are developed in logical sequence in the early units. Extreme care has been taken to present these topics with sufficient experimental data, and to discuss them fully and clearly in language readily understood by high school pupils.

(5) After the fundamental facts, theories, and principles have been introduced and developed, they are constantly utilized to account for common observations and experiences. For example, the operation of the storage battery and the corrosion of metals are explained in terms of ions and electrons; they are not considered simply as material to be studied and memorized.

(6) The first five units lay the foundation for a modern elementary course in high school chemistry; the last six units are presented in a recommended sequence, although the order of presentation may be altered as the instructor desires.

(7) A serious effort has been made to present a balanced course in beginning chemistry. This applies not only to the attempt to include all aspects of general chemistry, but also to the attention given to maintaining a healthy balance between theoretical and practical chemistry, both within and among the various units.

(8) Provision has been made for individual differences in ability, capacity, and interest among students. At the end of each problem is a set of exercises designed to provide drill work on the minimum essentials of that problem. After the problems, optional material is given in each unit which will furnish more capable or more interested students with an opportunity to secure greater depth or breadth in their mastery of the unit. This optional material takes the form of "Additional Problem Summary Exercises," "Exercises in Chemical Arithmetic," and "Topics for Investigation and Reports."

(9) "Topics for Oral or Written Recitation" are listed at the end of each unit. They are designed to serve as an effec-

tive summary of the fundamentals intended to be mastered, and to provide all students with the opportunity to discuss these fundamentals in oral or written form.

It is suggested that in conducting the unit recitation, each student be required to write a paper on one of the topics given in the list, or on a suitable substitute. It is also suggested that in so far as time and class size permit, each topic be discussed orally before the class by some member of the class, and that each student be given as many opportunities for oral recitation as possible during the course.

Thus it is apparent that *Modern-Life Chemistry,* especially when used in conjunction with *Comprehensive Units in Chemistry* or with the laboratory manual which has been prepared to accompany this text, provides *a complete program for the teaching of chemistry,* including:

a. A modern philosophy of aims and objectives
b. Carefully selected subject matter and activities
c. An effective and simple organization of the materials of instruction
d. A suggested technique of instruction
e. A complete testing program especially designed to facilitate intelligent and effective remedial instruction

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It seems fitting, also, to acknowledge the influence exerted by the writings of advanced thinkers in the field of science education. Included in such literature are:

1. Beauchamp, W. L., *Instruction in Science.* U. S. Office of Education Bul., 1932, No. 17, Monograph 22.
2. Downing, E. R., *An Introduction to the Teaching of Science.* University of Chicago Press, 1934.
3. Downing, E. R., *Teaching Science in the Schools.* University of Chicago Press, 1925.
4. Hunter, G. W., *Science Teaching.* American Book Co., 1934.
5. Morrison, H. C., *The Practice of Teaching in the Secondary School.* University of Chicago Press, 1931.
6. National Education Association, Committee Report, *Reorganization of Science in Secondary Schools.* Bureau of Education Bul., 1920, No. 26.
7. National Society for the Study of Education, Thirty-first Yearbook, Part I, *A Program for Teaching Science.* Public School Publishing Co., 1932.
8. Twiss, G. R., *Principles of Science Teaching.* The Macmillan Co., 1917.
9. Numerous books and magazines dealing with chemistry and related subjects, which served as invaluable reference materials.

We accept full responsibility for any errors that may have been overlooked during the preparation of this book, and will appreciate having them brought to our attention.

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FLOYD F. CARPENTER

INTRODUCTION TO THE STUDENT

You are about to begin a study of chemistry that presumably will extend through at least one school year. To help you succeed in this study, the following sections have been prepared for you to read and to think about. They attempt to answer some of the most vital questions asked by beginners in chemistry.

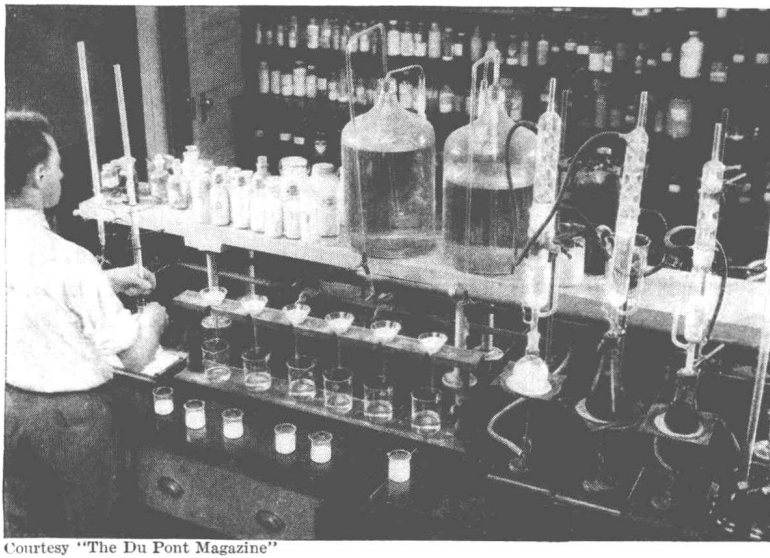
What does modern-life chemistry deal with? Everything in the universe is made up of chemical materials, some of which are common enough to be familiar to everyone. Earth, air, water, petroleum, metals, rocks and minerals, wood, rubber, and coal are examples. Chemistry teaches us about the characteristics and uses of such things, and of the simpler substances out of which they are made.

We also learn in chemistry how such materials can be altered so as to be of greater value to man. Chemistry tells us how paper and rayon can be made from wood. It teaches us how medicines, dyes, explosives, and flavoring agents are made from coal. By means of chemistry, special kinds of metals have been prepared that make our automobiles, trains, airplanes, and ships safer and more serviceable. Cement, glass, and pottery are among the hundreds of products made from minerals which we get out of the earth. Among the more common minerals which have high chemical value, salt, limestone, sand, and clay may be mentioned.

Modern-life chemistry tells us about the food we eat and the clothing we wear. We learn how to maintain soil fertility to grow better foods, and we learn what happens to our food when it undergoes digestion. In this connection, it may be mentioned that the green leaf and the human body are perhaps the most wonderful chemical laboratories known; both are related to the production and use of food. The characteristics of different fibers have a chemical explanation, and we also

learn how cloth made from such fibers can be bleached and dyed.

The preceding discussion is by no means exhaustive (that would require a large book by itself), but it gives ample evi-



Courtesy "The Du Pont Magazine"

Fig. 1. In many laboratories, like the one shown above, experimentation and investigations are being carried on continually. These studies often result in the discovery of new products or in new applications which are of great value and benefit to man.

dence of the practical value of chemistry, and of its relationship to industry, agriculture, medicine, and the home.

Why study chemistry? In answering this question, some reasons have already been suggested as to why modern-life chemistry is a worth-while subject to study. Let us consider some others, both from the standpoint of the individual and of society.

Louis Pasteur said, "Science is the soul of the prosperity of nations and the living soul of all progress. What really leads us forward are a few scientific discoveries and their ap-

plications." That country with a population having a working knowledge of chemistry will have an extremely valuable asset. It will have great chemical industries; its waste products will be converted into useful materials; it will possess strong, hard metals and powerful machinery; it will have efficient communication and transportation systems; it will construct warm, well-ventilated homes and buildings; and most important of all, the health of its people will continually reach higher and higher standards.

In this day, everyone will find that a knowledge of chemistry is a decided asset, regardless of his vocation. The farmer tilling the soil, the detective solving a crime, the doctor treating a serious ailment, the magician performing a trick, the tradesman buying materials for construction, the housewife preparing a meal—all have a definite need for chemical knowledge.

Students who seek the true explanations of commonplace things and happenings will find chemistry more than interesting. A command of knowledge that helps to expel from our vocabulary such expressions as "I guess" and "they say" is a vital aid in putting to rout the greatest enemies of science: namely, ignorance, superstition, hearsay, prejudice, and intolerance. In addition to providing information, the study of true explanations will help to clarify the thinking of everyone, and the mental exhilarations that result are very gratifying.

It is not expected that everyone who studies high school chemistry will become a professional chemist. Chemistry plays an important part in the daily lives of all of us, and some may find a thread of vocational interest among the many applications of chemistry to the fields of agriculture, industry, medicine, national welfare, and pure research. But aside from all of this, chemistry is worth while because it is the study *par excellence* for portraying the effect and value of scientific methods and attitudes in human behavior. The value of these methods, habits, and attitudes is not confined to chemistry, but carries over into fields of endeavor apparently quite remote from

science. As Professor Horace G. Deming of the University of Nebraska says, "An increased capacity of enjoyment, a livelier interest in the world in which we live, a more intelligent attitude toward the great questions of the day are the by-products of a well-balanced education including chemistry." [1]

By way of summary, then, your study of chemistry will be worth while if it gives you (1) a command of useful knowledge, (2) an understanding of significant chemical ideas, and (3) an opportunity to practice the scientific method of thinking and to develop a scientific attitude—all of which will help you to live and act more efficiently and more intelligently.

How to study chemistry effectively. In beginning your study of chemistry, try to develop study habits that will assure success. Plan your study program so you will be able to give daily a reasonable amount of time and energy to your chemistry. Remember that the worth of your study period is affected by physical conditions. Best results are obtained when you study in a quiet room that is well lighted and well ventilated. Your mental attitude also influences the effectiveness of your study period. Make a firm decision to meet your assignment, and keep your ambition, enthusiasm, effort, and attention burning brightly. Remember that perseverance, self-reliance, patience, judgment, and pride in work well done are the qualities that promote success. Many students develop a system of taking notes as they study. They do this because they know that the results obtained more than compensate for the extra effort required.

The course presented in *Modern-Life Chemistry* has been arranged to make it easier for you to master chemistry. It is divided into eleven units, each of which deals with a fundamental idea, principle, or aspect of chemistry. Within each unit, numerous study helps are provided. Their purpose is to help you avoid forming the bad habit of relying solely on memory, and to attain a true *understanding* of the fundamentals presented. In other words, we shall *assimilate* the big ideas, the principles, and the generalizations of chemistry.

[1] *Science Leaflet:* 10, VIII, Mar. 14, 1936, State College, Penn.