CHEMISTRY

A MODERN COURSE

SMOOT
PRICE
BARRETT

06
S666

8961630

赠阅

CHEMISTRY

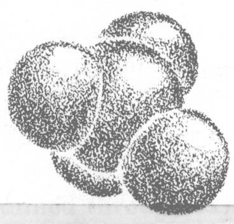
A MODERN COURSE

华南工学院
图书馆藏书

ROBERT C. SMOOT
McDonogh School
McDonogh, Maryland

JACK PRICE
Department of Education
San Diego County
San Diego, California

RICHARD L. BARRETT, Consultant
New Mexico State University
University Park, New Mexico



E8961630

CHARLES E. MERRILL BOOKS, INC.
COLUMBUS, OHIO

A Merrill Science Text

Copyright ©, 1965, by CHARLES E. MERRILL BOOKS, INC., Columbus, Ohio, 43216. All rights reserved. No part of this book may be reproduced in any form, by any method whatsoever, without permission in writing from the publisher.

Printed in the United States of America

赠阅

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	15.999
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.

PREFACE

Chemistry: A Modern Course presents a sound treatment of the principles of chemistry at a level suitable for the majority of high school students. The text has been developed within the framework of certain unifying concepts. Among those concepts stressed are the chemical bond, the structure of matter and the matter-energy relationships, the periodicity of the chemical elements, the mole concept, equilibrium, and chemical notation. Descriptive chemistry is treated either as an outgrowth of these concepts or as the point of entry. The line drawings, tables, graphs, and photographs are related to the principles of chemistry rather than to technology.

Throughout this text, the student is encouraged to think independently. Questions are frequently presented which require original reasoning. The student may be able to check his conclusion by performing a simple experiment or by turning to further reading. A minimum of emphasis has been placed on the memorization of facts. Wherever possible, principles have been illustrated by reference to evidence obtained through experiment. Examples have been selected that are closely related to the average student's past experience, following that most basic learning principle of proceeding from the known to the unknown.

The initial chapters present some descriptive chemistry as well as the "mechanics" of chemistry. This approach facilitates the early introduction of laboratory work. Several chapters are devoted to the structure of matter and the periodicity of the elements. The principles developed in these chapters provide the vehicle for the remainder of the text. The mole concept, stoichiometry, and solutions are discussed in logical order. Following this

此为试读，需要完整PDF请访问：www.ertongbook.com

sequence, the text deals with the behavior of matter in terms of acidity, oxidation-reduction, electric potential, rate of reaction, and equilibrium. It concludes with descriptive material in organic, colloid, coordinate, analytic, and nuclear chemistry. Each of these sections leads naturally into the next, and yet each can be set off as a pedagogically useful division.

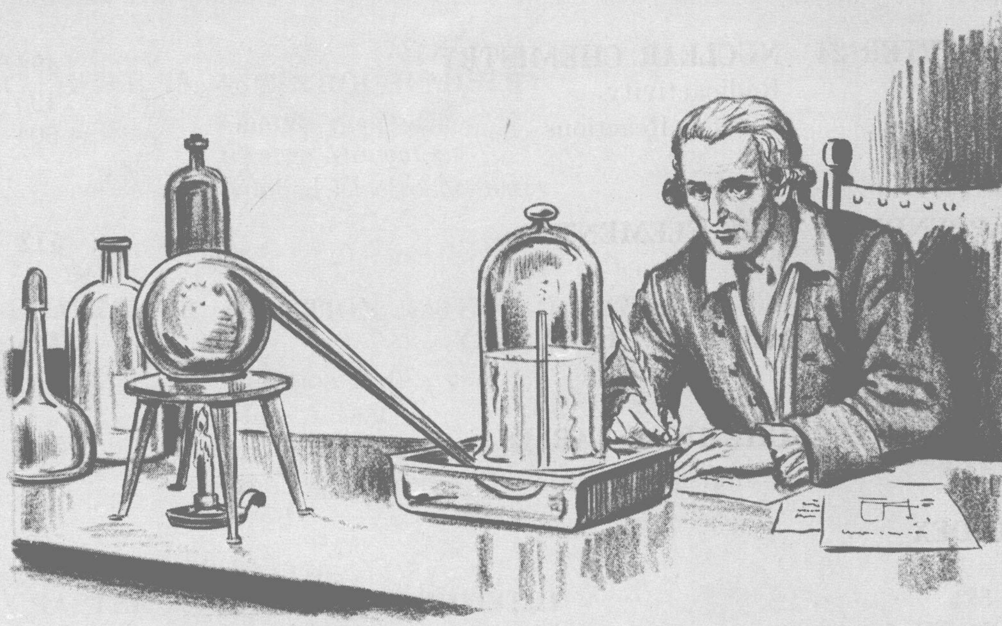
In many instances, problems follow immediately after the section pertaining to their solution. A comprehensive list of problems of a cumulative nature appears at the end of each chapter. These include numerical problems, as well as questions intended to test the student's understanding. Another feature is a series of problems entitled "One More Step," which may be used to lead the student into projects, papers, talks, or collections which can benefit the entire class. An extensive summary has been placed at the end of each chapter. A unique system of marginal notation appears throughout the text to highlight salient points and to assist the student in organizing his study and review.

The tabular material and the appendices include supplementary data. This enables the teacher to compose his own problems without resorting to the preparation of extra tables for the students.

Separating the chapters are brief biographies of men of science who contributed discoveries upon which the principles in the succeeding chapters are based. Such a historical perspective gives the student an appreciation of the great developments in chemistry and endows him with some sense of responsibility for future progress.

Throughout, this text reflects the consensus of recent recommendations made by committees studying the chemistry curriculum. In harmony with the best current thinking of scientists and educators, it takes into account a realistic appraisal of the capability and maturity of the typical student.

The authors wish to express their sincere thanks to the many chemistry teachers and science educators who have reviewed the manuscript during the various stages of its development. This assistance has ensured that *Chemistry: A Modern Course* is scientifically accurate and firmly based in the reality of the high school classroom.



Antoine Laurent Lavoisier
(1743-1794)

Often referred to as the father of modern chemistry, Lavoisier was certainly one of the outstanding scientists of the eighteenth century. He was the first to grasp the true explanation of combustion overthrowing the phlogistic doctrine that had handicapped the development of chemistry for more than a century.

Lavoisier contended that fire was the result of rapid union of the burned material with oxygen. Nothing, however, he maintained, was lost through this action. His theory directly opposed the phlogistic notion that combustible bodies lost something when burned.

Founded on Lavoisier's oxygen theory, a new system of nomenclature was evolved; one which held that oxygen was an essential constituent of all acids. His theories were the basis for great advances in chemistry.

As a young man of many interests, he studied astronomy, botany, and mathematics, as well as chemistry at the Collège Mazarin near his Paris home. Of key significance in his later life was his study of law and his admission to the bar. This led to an interest in French politics, whereupon he accepted a position as tax collector at the age of 26. While in government work he helped develop the metric system to secure uniformity of weights and measures throughout France.

His governmental interests, however, eventually proved his undoing. As one of 28 French tax collectors Lavoisier was branded a traitor by revolutionists in 1794 and guillotined at the age of 51. Ironically, Lavoisier was one of the few liberals in his position and had strived for many years to alleviate the hardships of the peasants.

CONTENTS

此为试读，需要完整PDF请访问：www.ertongbook.com

CHAPTER

1

Experimentation and Chemistry

Why is a lemon yellow instead of blue? Why does ice float in water? Why does gasoline burn? To many people, and perhaps to you, these questions have seemed interesting enough to investigate. Today we can find the answers to these questions in books. But what about the question, "How many different kinds of plastic is it possible to make?" Or, "Is there a drug that can cure cancer?" These questions and many others have not been answered. Some people are presently investigating them. These investigators are called *scientists*. In addition to performing investigations, scientists also gather and organize information.

A scientist in a laboratory is working with two substances, one is in the form of white, needle-shaped crystals—phenol—and the other is in the form of a colorless liquid—formaldehyde. He notices that these substances interact to produce a dark-colored plastic material. He recognizes the material as plastic because it is pliable and can be molded. From his training in chemistry, the scientist can recall two principles which may aid in producing a new, similar plastic material. First, he knows that substances with similar molecular structures act similarly. Second, he remembers that cresol is similar to phenol. With this information at hand, he can predict that cresol and formaldehyde will interact to produce a new plastic material. He can then try such a combination and note the results. Such a test will show that cresol and formaldehyde do indeed form a new plastic material that is similar to the phenol-formaldehyde plastic.

SCIENTIFIC PROCEDURES

Scientific procedures:
observation
inference
prediction
experimentation.

In real life, as in mystery tales, criminals are often apprehended because they show certain recognizable patterns of behavior. The police observe the method of operation in a crime, draw inferences as to the possible culprits, predict where the next similar crime may occur, and often apprehend the criminals quickly. This method is known as "scientific crime detection." It is probably called this because, in investigations of unanswered questions, scientists usually follow similar procedures which have been found to be helpful. These procedures include the activities of observation, inference, prediction, and experimentation.

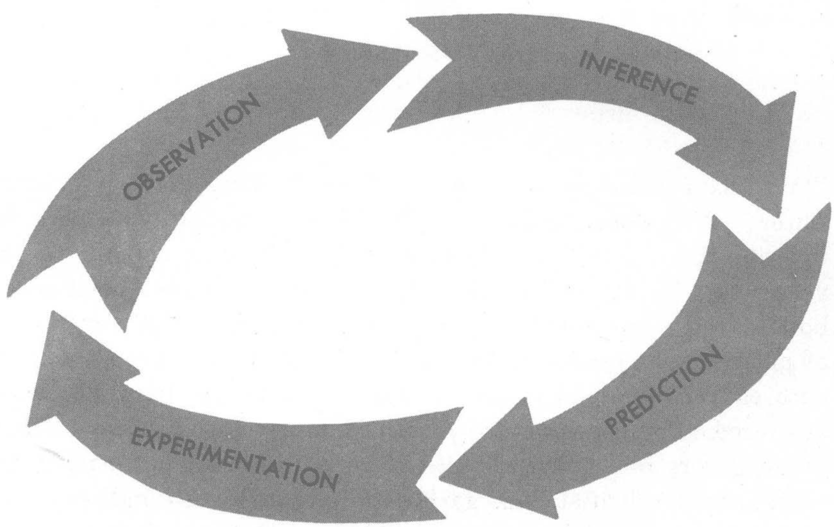


FIGURE 1-1. The scientific procedures, observation, inference, prediction, and experimentation can be used in any problem solving situation.

Let us examine a typical sequence of these procedures. Remember, each one may play a key role in the solution of a problem being investigated.

1:1 Observation

Often before a problem is investigated, the first step toward its solution has already occurred; namely, *observation*. If someone had not observed something, a question would not have been asked. In our example, the scientist looking for new plastics "observed" that phenol and formaldehyde form a plastic material.

To observe means to take notice.

Observations can be made with any of the five primary senses. Therefore, the observer can see, hear, smell, taste, or feel something which arouses his curiosity. (In reality, we have more than five senses—for example, our senses of temperature and balance—but the five senses mentioned here are our most usual means of observing the environment.) Frequently, an observer uses some instrument—for example, a microscope or telescope—to supplement his sight. He may use an amplifier or stethoscope to supplement his hearing. There are also instruments to supplement the senses of smell, taste, and touch.

Observations are made by means of our senses.

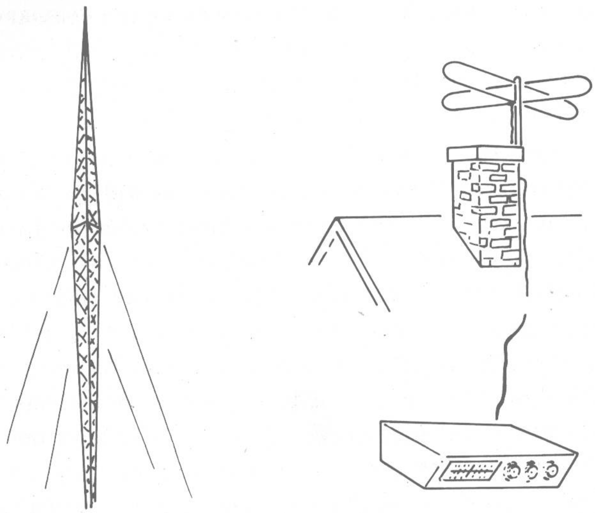


FIGURE 1-2. A radio receiver detects, transforms, and amplifies radio waves.

Many events cannot be detected by our senses. Instruments have been devised which not only detect these events, but transform them in a manner that enables us to observe the event. A familiar example is the radio. We are unable to detect radio waves in the air, but a radio can and does. It detects the radio waves which cause it to produce sound waves that we can easily detect or hear.

Instruments can convert events from one form to another.

1:2 Inference

To infer means to reason in a particular way.

Knowledge and experience aid reasoning.

The things that we observe are facts. With the proper knowledge and experience, we are able to relate certain observed facts to similar events within our experience, and assume that a particular event has taken place. For instance, upon hearing a radio produce intelligible sounds, we may logically suppose that a broadcasting station is producing radio waves which are carrying those sounds. This supposition is called an *inference*. The process of inferring is "reasoning through" the observed facts. It is another one of the scientific procedures. The example of the relationship between a radio and a broadcasting station is a very simple one. Most inferences require more complex reasoning.

In our original example, the scientist was able to infer that a material with a chemical structure similar to phenol would behave much the same as phenol. He would also have had to make many other inferences concerning the conditions under which the test should be conducted, if he were to have a successful investigation. A large amount of knowledge and experience is necessary to make good inferences.

1:3 Prediction

To predict means to foretell.

Another procedure used in scientific investigations is *prediction*. This activity requires a vivid imagination, as well as a sound background. An investigator may predict that a change in the conditions existing when he made his observation will produce a new set of facts that will enable him to answer the original question. On the other hand, he may predict that the fact which he has observed is related to other known facts in a particular manner. He may also infer the cause of the occurrence he has observed. These predictions and inferences are given the technical name of hypotheses. A *hypothesis* is a supposition which may or may not be true. It is sometimes referred to as an "educated guess." However, it is more than just a guess, since only an individual with adequate training is likely to prepare a worthwhile hypothesis: the scientist predicted that cresol and formaldehyde would produce a new plastic.

A hypothesis is a tentative supposition.

1:4 Experimentation

To experiment means to test.

After formulating his hypothesis, the investigator must test it to determine if his prediction is correct. To make a test, it is necessary to plan an *experiment*. Again, knowledge, experience, and imagination are important. In planning an experiment, the investigator may even have to design new instruments with which to carry out the investigation. In performing the experiment, the investigator tests what he believes to be the answer to the question he is investigating. He may repeat his experiment successfully hundreds of times, *yet his hypothesis will never be proved beyond doubt*.

Whether his hypothesis has been *satisfactorily* proved is decided by beginning the cycle of procedures all over again; that is, from his experiments the investigator makes certain observations. He then must analyze the facts gathered in these observations to determine the reliability and certainty of his hypothesis. Once he has satisfied himself that his hypothesis is correct, the scientist then publishes his results, together with a complete description of his experimental methods. This enables other investigators to verify or disprove his conclusions.

An investigator sometimes goes to all this trouble and then proves his hypothesis to be wrong. We know from mathematics that it takes only one counterexample—just one experiment which does not give the predicted results—to prove that a hypothesis is wrong. If this happens, has the investigator's effort been wasted? Certainly not. By proving his hypothesis incorrect, he has eliminated one possible answer to the question and has saved other investigators from doing the same thing. He has also put himself in a position to make new inferences, new predictions, and new experiments based on his new facts. Thus, even if he is incorrect in his hypothesis, he has still contributed to the knowledge of mankind.

From the preceding discussion, we should realize that scientific procedures are repetitive processes, with no fixed order, that continue until the original question is answered. Events need not follow the order given above and in Figure 1-1. Observation is a part of experimentation, hypotheses may be revised on the basis of experimental data, and inferences may be made at any time. As we continue the study of chemistry, we shall often see that answers to questions raise new questions and, therefore, start the process all over again.

Scientific procedures are repetitive processes.

1:5 Laws and Theories

On the basis of many observations, it is sometimes possible to note that, in a given set of conditions, the same event will always occur. A statement generalizing the behavior of nature under a given set of conditions is called a *law*. A law is not necessarily

A law describes what happens under given conditions: it offers no explanation.

此为试读，需要完整PDF请访问：www.ertongbook.com