TEACHER'S ANNOTATED EDITION

CHEMISTRY

A MODERN COURSE

SMOOT PRICE SMITH

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PREFACE

The *Teacher's Annotated Edition* for the sixth edition of ***Chemistry: A Modern Course*** is an integral part of the Merrill Chemistry Program. In one book, you have at your fingertips all of these important features: detailed solutions to all questions and problems in the text, a planning guide, suggested teaching aids, demonstrations, and teaching strategies and techniques for presenting text material.

Using this Annotated Edition, you will find that it is not necessary to carry with you two or more easily misplaced supplementary books. All of the materials you will need are in this Annotated text. Thus you eliminate the time consuming, frustrating, and often fruitless search for usable supplementary materials.

The comments, notes, and suggestions are concise and written with an awareness of the classroom situation. The *Teacher's Annotated Edition* is designed to make your teaching of chemistry effective.

The *Teacher's Annotated Edition* can be divided into two parts:

Annotated Pupil's Pages. The annotations are concise statements overprinted in red on the Pupil's text. Each annotation is directly applicable to the section or problem where it is located. Demonstrations are used to introduce chapters and sections where appropriate. Answers are provided for most problems (where space allows) for your convenience.

Teacher's Guide. The Teacher's Guide appears at the front of the *Teacher's Annotated Edition.* These pages have grey edges to set them off from the Pupil's text. The Teacher's Guide is a compilation of the complete problem solutions together with explanations and comments arranged in consecutive order as they appear within the text. The introductory section of the Teacher's Guide provides you with some insight as to our philosophy in teaching chemistry and the features of the text and other components of the Merrill Chemistry Program. The Teacher's Guide is organized to allow you to locate material quickly and check assignments. Performance objectives are included for each chapter. The introductory materials also include a discussion on using performance objectives, audiovisual aids, and literature references.

A questionnaire is included on the last page of the Teacher's Guide. It is our hope that you will take the time to complete it after you have thoroughly reviewed this text. It is our goal to consistently provide a text to meet your teaching needs.

The Authors

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PHILOSOPHY

Chemistry: A Modern Course is organized around a central theme: the properties of matter are a consequence of its structure. We feel that before a detailed study of structure can be pursued, it is necessary to establish a working "vocabulary" between students and teacher. This vocabulary is established in the first seven chapters of the text. The organization of the early chapters allows you to begin quantitative lab work early in the course. Students get the motivational benefits of hands-on activity while studying the more concrete aspects of chemistry. Chapter 1 indicates the function of chemistry in society. Chapter 2 reviews basic measurement principles and mathematical techniques which are important in problem solving and laboratory work. In addition, the factor-label method of problem solving is introduced here. Note that the International System of measurement is used throughout the text after its introduction in Chapter 2. We believe students should learn these units as they are the proper foundation for communication among scientists all over the world. Chapter 3 outlines the basic classification system for matter. Chemical symbols and formulas are covered in Chapter 4. Chapter 5 begins an elementary study of the stoichiometry of compounds with an emphasis on the mole as the chemist's basic counting unit. Chapter 6 introduces the chemical equation as a shorthand representation of chemical change, while Chapter 7 covers the mass and energy relationships associated with chemical change. Thus, with the first seven chapters as a framework, students can now move on to more abstract concepts.

The study of structure begins with Chapters 8-11 concerning the atom. In Chapter 8, atomic theory, subatomic particles, and basic ideas about the structure of atoms are discussed. A more detailed look at the theory and behavior of electrons in atoms is the subject of Chapter 9. Atoms are classified, based on their structure, into the periodic system in Chapter 10. Properties of some elements as a consequence of their atomic structure comprise the subject matter of Chapter 11.

Combining atoms into compounds is covered in Chapters 12-14. Chapter 12 discusses the underlying principles of chemical bond formation, while Chapter 13 concerns the bonds themselves and their geometric arrangement in molecular structures. Properties of polar molecules as a consequence of their structure are discussed in Chapter 14.

Chapters 15-19 consider groups of molecules and ions beginning with their kinetic behavior. Chapter 15 presents the physical states of matter as a consequence of their thermal behavior. Chapters 16-19 introduce the basic principles of the three common physical states as a consequence of their structure. Solids are covered first as they are more familiar to students. Gases are covered last since their characteristics are less easily observed. The mole is reintroduced in Chapter 19 in connection with Avogadro's principle in developing the ideal gas equation.

Chapter 20 brings together various concepts of energy and disorder which have been introduced at appropriate points earlier in the text. These ideas are organized into a formal presentation of elementary thermodynamics.

Chapters 21-27 consider aggregates of molecules and ions of different kinds. Nonreacting homogeneous mixtures are covered in Chapter 21. The properties of solutions and colloids on the basis of their structure are covered in Chapter 22. Chapter 23 begins reacting mixtures on the basis of rate and establishing equilibrium. Heterogeneous mixtures are included. Acids and bases are discussed is Chapter 24 with emphasis on their behavior in water solution. The content of Chapter 25 concerns salts and their behavior in water. Chapter 26 presents reactions in which electron transfer takes place and Chapter 27 introduces the interaction of electricity and chemical species.

Chapter 28 introduces the specialized area of nuclear chemistry. This vital area of our present economy is a high interest subject for students. The nomenclature and structure of the simplest classes of organic compounds are covered in Chapter 29. The reactions of organic compounds with emphasis on petroleum products, synthetic materials, and biochemical systems concludes the text in Chapter 30.

Throughout this text, we have used the basic learning principle of proceeding from familiar or known information to the unknown. As you can see from the sequence of chapters, we recognize that a certain amount of repetition is a necessary part of the learning process. Thus, principles of structure, matter-energy relationships, the mole concept, thermodynamics, and chemical equilibrium are presented several times throughout the text with varying degrees of emphasis. We believe students will develop a sense of confidence when they recognize familiar concepts presented later in greater depth. Minimum emphasis has been placed on memorization of fact. Instead, our purpose is to foster understanding and the ability to predict consequences.

CHEMISTRY: A MODERN COURSE

AN INTRODUCTORY CHEMISTRY TEXT AND RELEVANT

Content that focuses on basic chemical principles while giving students a better understanding of their world.

Written by experienced educators in science and mathematics, ***CHEMISTRY: A MODERN COURSE*** reflects the preferences of science educators throughout the country.

The **sequence** of chapters provides for an understanding of chemical principles without the tedious memorization of equations and facts.

Chapters 1-7 provide the vocabulary to be used throughout the course. The study of atomic structure, bonding, kinetic theory, physical states, solutions, energy, equilibrium systems, redox, and analytical techniques comprise the bulk of the text. Chapters 28-30 are devoted to basic information on nuclear, organic, and biochemistry.

CONTENTS

CONTENTS

THAT IS BOTH COMPREHENSIVE

The Great Pyramid is a symbol of human ingenuity. The pyramid contains over 2 million stone blocks each having an average mass of 2300 kilograms. It stands 137 meters high with a base covering 50 000 square meters. In comparison, consider a diamond chip having a mass of 1 gram. This chip contains over 5×10^{23} carbon atoms. Think of the difficulty a chemist encounters in building molecules from single atoms. It is much more practical to work with a large amount as a single unit. The mole is a chemist's counting unit. What number of objects does a mole represent? Why was this particular number selected to represent a mole?

THE MOLE 5

Chapter 5 introduces the mole and the use of this concept in manipulating formulas. Students are expected to set up and solve quantitative problems.

Demonstration—Place some $CuSO_4 \cdot 5H_2O$ in a large test tube. Heat it over a flame until the blue color disappears. Place the white anhydrous $CuSO_4$ on a watch glass and add H_2O from a dropper. **CAUTION:** exothermic. Discuss how quantitative information can be used to completely describe our observations.

Chemical symbols and formulas (such as H and H_2O) are shorthand signs for chemical elements and compounds. The symbol of an element may represent one atom of the element. The formula of a compound may represent one molecule or one formula unit of the compound. Symbols and formulas may also represent a group of atoms or formula units. Since atoms are so very small, chemists deal with large groups of atoms. This chapter is about a group called a mole, containing a specific number of units.

GOAL: You will demonstrate your understanding of the mole concept by using it in calculations with chemical formulas, solutions, molecular formulas, and hydrates.

Point out that elements can have formulas such as I_2, S_8, and P_4.

5:1 MOLECULAR MASS

The masses of the atoms are compared by using the **atomic mass scale.** This scale has the "atomic mass unit" (amu) as a standard. The source of this standard will be discussed in Chapter 8. A list of atomic masses for the elements is found on the inside back cover of the book.

The atomic mass unit is used to compare masses of atoms.

The data in the atomic mass table gives relative masses of the elements.

The atomic mass of hydrogen in atomic mass units is 1, and the atomic mass of oxygen is 16. Therefore, the total mass of a water molecule, H_2O, is $1 + 1 + 16$, or 18 amu. If the atomic masses of all the atoms in a molecule are added, the sum is the mass of that molecule. Such a mass is called a **molecular mass.** This name is incorrect when applied to an ionic substance. Sodium chloride, NaCl, is an ionic substance which does not exist in molecular form. A better name for the mass of ionic substances is formula mass. The sum of the atomic masses of all atoms in the formula unit of an ionic compound is called the **formula mass** of the substance. To calculate a formula mass add the masses of all the atoms in the formula.

Molecular mass is the sum of the atomic masses of the atoms in the molecule.

Formula mass is the sum of the atomic masses of the atoms in a formula unit.

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A format designed to motivate and provide a successful learning experience.

The Pupil's text is overprinted in red with **Teacher Annotations.** Thus, answers, points of emphasis, teaching strategies, and demonstrations are conveniently located with the text material.

The 30 chapters are subdivided into **numbered sections** allowing you to flexibly plan your assignments.

Full color chapter openings provide students with a purpose for studying the chapter.

Readability is enhanced by using a single column format leaving the margin free for student notes and annotations to highlight important information.

Reading and study aids designed to remove any obstacles students may encounter in learning.

Student margin notes, printed in blue, highlight important points. Thus, students are not faced with the problem of discerning what is important from a mass of new material.

A **Goal,** found in statement form at the beginning of each chapter, identifies the major objective to be accomplished in studying the chapter.

Phrases and sentences to be emphasized are printed in italic type.

Numbered sections provide students with a ready outline of the chapter. Thus, students are better able to see the relationships among concepts.

New terms are highlighted in boldface type. They are used repeatedly allowing students to establish a familiarity with the term and its definition. All new terms are clearly defined in the Glossary.

COLLIGATIVE AND COLLOIDAL PROPERTIES 22

GOAL: You will gain an understanding of the properties of solutions that depend upon the number of particles, size of the particles, and the type of particles in the solution.

When a solute is dissolved in a solvent, there is a change in certain properties of the solvent. On the other hand, when particles too large to dissolve are dispersed throughout a liquid, the solvent's properties remain unchanged. In this chapter, we want to investigate those properties of solvents which are changed by solutes. We also want to look at the behavior of those particles which are too large to dissolve and have no effect on the liquid. Throughout the first six sections of this chapter, we will be dealing with an ideal solution. In Chapter 18, we were able to define an ideal gas. Unfortunately, we cannot define an ideal solution completely at this point. For the time being, we will just say that the particles of solute in an ideal solution have no effect on each other.

22:1 RAOULT'S LAW

Colligative properties depend on the number of particles in solution.

Colligative properties
1. vapor pressure
2. freezing point
3. boiling point
4. rate of diffusion through a membrane

All ionic and molecular solids having low vapor pressures are said to be nonvolatile.

Colligative properties are determined by the number of particles in solution rather than by the type of particle in solution. The properties so affected are vapor pressure, freezing point, boiling point, and the rate of diffusion through a membrane. Consider a solute dissolved in a liquid solvent. Some of the solute particles take up space on the liquid surface normally occupied by solvent particles. These solute particles decrease the opportunity for solvent particles to escape (evaporate) from the liquid surface. Thus, if the solute is nonvolatile, the vapor pressure of a solution is always less than that of the pure solvent at the same temperature. The lowering of the vapor pressure of the solvent varies directly as the mole fraction of dissolved solute. *Any nonvolatile solute at a specific concentration lowers the vapor pressure of a solvent by an amount which is characteristic of that solvent.* The characteristics of the solute are not involved. Ionic

An approach to problem solving that reinforces the content without the burden of memorization.

EXAMPLE: Volume of a Dry Gas

A quantity of gas is collected over water at 8°C in a 353-cm^3 vessel. The manometer indicates a pressure of 84.5 kPa. What volume would the dry gas occupy at standard pressure and 8°C?

Solving process:

(a) We must determine what part of the total pressure is due to water vapor. Table 18-2 indicates that at 8°C, water has a vapor pressure of 1.1 kPa. To find the pressure of the collected gas:

$$\begin{aligned} P_{gas} &= P_{total} - P_{water} \\ &= 84.5 \text{ kPa} - 1.1 \text{ kPa} \\ &= 83.4 \text{ kPa} \end{aligned}$$

(b) Since this pressure is less than standard, the gas would have to be compressed to change it to standard. The pressure ratio by which the volume is to be multiplied must be less than 1. The correct volume is

$$\frac{353 \text{ cm}^3 \mid 83.4 \text{ kPa}}{\mid 101.3 \text{ kPa}} = 291 \text{ cm}^3$$

$V_2 = V_1 \left(\frac{P_1}{P_2}\right)$

Note that the temperature remains constant. See Table 18-2 page 362 for pressure corrections.

PROBLEM

5. The following gas volumes were collected over water under the indicated conditions. Correct each volume to the volume that the dry gas would occupy at standard pressure and the indicated temperature (T is constant).
   a. 888 cm^3 at 14°C and 93.3 kPa
   b. 30.0 cm^3 at 16°C and 77.5 kPa
   c. 34.0 m^3 at 18°C and 82.4 kPa
   d. 384 cm^3 at 12°C and 78.3 kPa
   e. 8.23 m^3 at 27°C and 87.3 kPa

5. a. 804 cm^3

18:4 CHARLES' LAW

Jacques Charles, a French physicist, noticed a simple relationship between the volume of a gas and the temperature. He found that, starting at 0°C, the volume of any gas would double if the temperature were raised to 273°C (pressure constant). For each Celsius degree increase in temperature, the volume of the gas increased by 1/273 of its volume at 0°C. If the original volume (at 0°C) is expressed as 273/273 = 1, an increase in temperature of 273° will result in a new volume of

$$\frac{273 + 273}{273}, \text{ or } 2$$

For each 1 C° change, a gas changes 1/273 of its 0°C volume.

Examples are used throughout the text as models for students in applying mathematical skill in solving chemical calculations.

Practice problems throughout each chapter enable students to review immediately the material just studied. Answers are provided to some problems allowing students to check their work.

SI units are used to provide students with the proper base for communicating in science. The simplicity of this measurement system drastically reduced the number of new units students will learn in the course.

A strong graphic presentation to help students visualize new concepts.

Tables are used to organize text information and quantitative data. The use of a tabular format allows students to see relationships among ideas and data at a glance.

Illustrations provide the visual models needed to fully understand abstract topics such as bonding, atomic and molecular structure, and large scale chemical processes. Graphs are used to show relationships between measured quantities.

Photographs are used to directly illustrate the text information or present additional applications and analogies to help students visualize difficult concepts. The captions reinforce the text or provide additional relevant information.

Table 13-1

Molecular Geometry

2 electron clouds	3 electron clouds	4 electron clouds
Linear	**Trigonal planar**	**Tetrahedral**
$HgCl_2$	$B(OH)_3$	CH_4

5 electron clouds	6 electron clouds
Trigonal bipyramidal	**Octahedral**

Iodine: Essential for the synthesis of thyroid hormones

Iron: Metallic center of hemoglobin; needed for the formation of vitamin A; component of some enzymes

Copper: Essential for hemoglobin synthesis; needed for bone formation and the production of melanin and myelin

Potassium: Maintains intracellular osmotic pressure and pH; needed for proper transmission of nerve impulses and muscle contraction

Each tablet contains:		% U.S. RDA*
Vitamins		
Vitamin A	5,000 Int. Units	100
Vitamin E	15 Int. Units	50
Vitamin C	60 mg	100
Folic Acid	400 mcg	100
Thiamine	1.2 mg	80
Riboflavin	1.7 mg	100
Niacin	14 mg	70
Vitamin B-6	2 mg	100
Vitamin B-12	6 mcg	100
Pantothenic Acid	10 mg	100
Minerals		
Iodine	150 mcg	100
Iron	10 mg	56
Copper	2 mg	100
Zinc	15 mg	100
Manganese	1 mg	†
Potassium	5 mg	†

*Percentage of U.S. Recommended Daily Allowances
†No U.S. Recommended Daily Allowance (U.S. RDA) has been established for this nutrient.

Ingredient List: Calcium Sulfate, Sucrose, Lactose, Sodium Ascorbate (Vit. C), Ferrous Sulfate, Zinc Oxide, Vitamin E Acetate, Nucinamide, Calcium Pantothenate, Potassium Sulfate, Cupric Sulfate, Artificial Color, Lacca, Gelatin, Povidone, Magnesium Stearate, Manganese Sulfate, Pyridoxine HCl (B-6), Vitamin A Acetate, Silica, Riboflavin (B-2), Thiamine Mononitrate (B-1), Folic Acid, Sodium Benzoate, Potassium Iodide, Carnauba and White Wax, Sesame Oil, Cyanocobalamin (B-12).

Doug Martin

Zinc: Component of several enzymes involved in digestion, respiration, bone formation, liver metabolism; needed for a normal healing process and good skin tone

Manganese: Component of enzymes involved in the synthesis of fatty acids and cholesterol; needed for the formation of urea and the normal functioning of the nervous system

FIGURE 11-17. Zinc is one of many elements essential to proper body function. Vitamin tablets act as a supplement in the event that one does not receive adequate amounts from the daily diet.

discovered. As an example, lack of zinc in the diet prevents the pancreas from producing some digestive enzymes.

Metallic zinc, like chromium, is corrosion resistant. It is used extensively as a coating to protect iron. The coating can be applied in three ways. When the iron is dipped in molten zinc, the process is called **galvanizing.** The coating is also applied electrically. The third method is to allow gaseous zinc to condense on the surface of iron. Another major use for metallic zinc is in the production of alloys. Especially important is its combination with copper to form brass.

Zinc is corrosion resistant.

A. Mercado/Jeroboam

FIGURE 11-18. Zinc discs are used on the underside of ships to prevent corrosion.

SUMMARY

1. A polar bond is one in which a shared pair of electrons is attracted more strongly to one of the atoms. 14:1
2. van der Waals forces are the net result of dipole-dipole, dipole-induced dipole, and dispersion effects. 14:2
3. A complex ion is composed of a central positive ion and molecular or negative ion ligands. 14:3
4. The number of ligands surrounding the central ion is the coordination number of a complex. 14:3
5. Complex ions which contain more than one type of ligand may exhibit geometric isomerism. 14:4
6. Small positive ions with a large nuclear attractive force form excellent central ions. The transition metal ions are good examples of these. 14:6
7. The bonds of complex ions have both ionic and covalent bonding characteristics. 14:6
8. Chromatography is a method of separating substances into identifiable chemical fractions by differences in their polarity. 14:8-14:11

PROBLEMS

7. The following pairs of atoms are all covalently bonded. Arrange the pairs in order of decreasing polarity of the bonds using Table 12-6.
   a. arsenic and oxygen
   b. chlorine and silicon
   d. oxygen and fluorine
   e. phosphorus and bromine

REVIEW

1. What shape would you predict for the NI_3 molecule? For CCl_4?
2. Describe the shapes of s and p orbitals.
3. Explain why carbon can form four equivalent bonds with a predicted outer configuration of $2s^2 2p^2$.
4. Why is benzene more stable than a compound with three single and three double bonds?
5. What shape would you predict for H_2Se? Why?
6. From molecular orbital theory, predict the stability of the He_2^+.
7. Draw as many isomers of C_5H_{10} as you can. Hint: There are 10 isomers and the compound contains one C=C double bond.
8. Predict the N—C=O bond angle in $(NH_2)_2CO$.
9. Draw isomers for compounds with the formula C_6H_6.
10. Draw resonance structures for SO_3.

ONE MORE STEP

1. In preparing paper chromatograms, identification of unknowns is aided by the measurement of R_f values. These values concern the distance an unknown has advanced compared to the distance the solvent has advanced. Research the chromatographic process to determine how these values are useful in identification.
2. Look up the structure of chlorophyll and hemoglobin. Determine the central ion and its coordination number. What is the coordinated group, and what is its spatial orientation about the central ion?
3. Medicine and industry use certain materials called chelating agents. What are they and how are they related to complexes?
4. A number of organic compounds are used in the analysis of inorganic ions because they form complex ions. Investigate the substances used in detecting nickel, aluminum, and zirconium by such a method.
5. Try to separate the pigments of spinach leaves using paper chromatography.

READINGS

Barth, Howard G., "Separations Using Liquid Chromatography." *Chemistry,* Vol. 50, No. 7 (September 1977), pp. 11-13.

Eliel, Ernest L., "Stereochemistry." *Chemistry,* Part I, Vol. 49, No. 1 (January-February 1976), pp. 6-10; Part II, Vol. 49, No. 3 (April 1976), pp. 8-13.

Kauffman, George B., "Left-handed and Right-handed Molecules." *Chemistry,* Vol. 50, No. 3 (April 1977), pp. 14-18.

Nassau, Kurt, "The Causes of Color." *Scientific American,* Vol. 243, No. 4 (October 1980), pp. 124-154.

Navratil, J. D., and Walton, H. F., "Ion Exchange and Liquid Chromatography." *Chemistry,* Vol. 50, No. 6 (July-August 1977), pp. 18-20.

A complete range of chapter review materials to meet your teaching needs.

Summary lists the major points presented in the chapter. Each statement is annotated for students allowing them to refer back to the section where the statement is presented.

Problems includes additional questions and practice problems enabling students to further check their understanding of the chapter before a test. The questions range from simple recall to the application of previously studied material to new situations.

Review includes questions and practice problems which cover material from previous chapters. Thus, students constantly build their knowledge base rather than treating each chapter as an isolated unit.

One More Step includes questions and activities which take students beyond the material in the chapter. These items are ideal for individualized study or extra credit.

Readings is a list of suggested references and high interest articles allowing students to explore chapter concepts in more depth.

CHEMISTRY: A MODERN COURSE

Additional features to provide a balanced approach to chemistry, thereby eliminating any need to supplement the text.

Appendices include a comprehensive set of reference data and supplementary information on logarithms and careers thereby eliminating the need to purchase expensive reference tables or handbooks.

Chemical Careers are short overviews of career choices requiring some knowledge of chemistry.

Biographies are brief insights into the lives and discoveries of scientists who have made a significant contribution to the field of chemistry.

Chemical Technology articles provide a brief insight into topics which supplement the chapter material or a current research problem.

APPENDIX B

LOGARITHMS

A logarithm or log is an exponent. We will work with exponents given in terms of base 10.

$$N = b^x$$

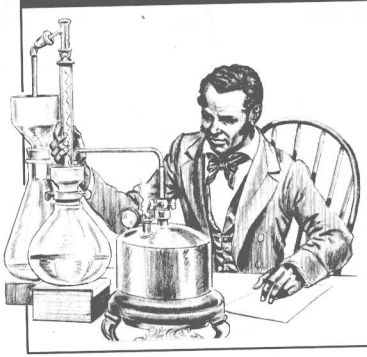
$$\text{number} = \text{base}^{\text{exponent or logarithm}}$$

$$100 = 10^{2.0000}$$

CHEMICAL CAREER: Chemical Engineering

Chemistry is a science. Engineering, on the other hand, is a particular approach to problem solving. The engineer uses the facts generated by scientists to solve everyday problems. Most engineers (and some chemists) deal with technology.

Though a chemical engineer performs many functions, a broad definition would be a person who designs, builds, and/or operates chemical plants or industrial plants using chemistry. The design function involves working with chemists who have investigated



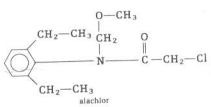
Norbert Rillieux was born in the United States; however he received his education in Paris, France. At the age of 24, he was teaching applied engineering at École Centrale. It was his interest in chemistry and steam engineering which returned him to the United States and led him to a process that revolutionized the sugar industry.

The crystallization of sugar from cane syrup had been done by ladling the cane syrup from vat to vat until the liquid evaporated. In 1846, Rillieux made use of the reduced boiling point of a liquid under a vacuum evaporator. This process produced a cheaper, better, and more automated method of crystallizing sugar. The same concept is now used in the manufacture of condensed milk, soap, and glue. It is also useful in the recovery of wastes from distilleries and paper factories.

CHEMICAL TECHNOLOGY: Herbicides

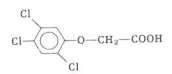
As the population of the world increases, it becomes more and more difficult to feed everyone. Scientists are constantly searching for ways to increase crop yields from farmland.

One method of improving farm productivity is to remove weeds which crowd paying crops. Herbicides are chemicals which kill weeds without harming the cash crop. Almost 200 different herbicides are available commercially in the United States.



alachlor

The most widely used herbicides are alachlor and atrazine. Another herbicide, one which has caused much controversy is 2,4,5-T (2,4,5-trichlorophenoxyacetic acid). This substance tends to accumulate in the ground and in water run-off from those fields where it has been used. Most herbicides used today are decomposed in the soil by bacteria within a year. Persistent herbicides, such as 2,4,5-T, can be a problem if they accumulate to levels that are harmful to animals and humans.



2,4,5-T

Scientists are constantly searching for microorganisms which can degrade these persistent herbicides. It is sometimes possible to control the evolution of such organisms over a long period of time by gradually changing their diets. Thus, organisms can be bred to naturally degrade some of these materials. There are many problems to be overcome in such research. For instance, a microorganism which thrives on a certain chemical in the laboratory may not be able to survive in the wild.

Ancillary materials to provide for hands-on learning, development of math skills, and evaluation of student progress.

Laboratory Program

Chemical concepts often appear abstract to students. ***LABORATORY CHEMISTRY*** provides students with an opportunity to investigate many of the concepts covered in ***CHEMISTRY: A MODERN COURSE.*** A teaching approach which combines lecture and textbook materials with practical laboratory experiences will enhance students' ability to comprehend new and difficult material.

The focus of ***LABORATORY CHEMISTRY*** is on a logical approach to investigating and analyzing problems. A wide variety of laboratory techniques which stress safety are presented. Accurate reporting of experimental data in a well organized laboratory report is emphasized. Students are then required to interpret their results in terms of the concepts being investigated.

LABORATORY CHEMISTRY is designed to be flexible for a variety of teaching needs. When time or cost is a prohibitive factor, teachers are encouraged to use experiments for class demonstrations. The Planning Guide on pages 14T-15T contains a suggested laboratory sequence which correlates the experiments with the text material.

Problem Solving

Students often encounter difficulty in applying their mathematical skills to chemical calculations. ***SOLVING PROBLEMS IN CHEMISTRY*** is designed to develop problem solving skills through the use of *Example* and practice problems. This paperback text contains a minimal amount of reading material and focuses strictly on problem solving. The factor-label method is used as in the text ***CHEMISTRY: A MODERN COURSE.*** Each Example problem has a carefully explained step-by-step solving process. Emphasis has been placed on the practical applications of problem solving in chemistry. Industrial and everyday uses of chemicals are discussed within the problems.

Solving Problems in Chemistry is an excellent source of supplementary problems and exercises for developing problem solving skills.

Evaluation of Student Progress

The ***EVALUATION PROGRAM FOR CHEMISTRY: A MODERN COURSE*** is designed to be used as a learning tool as well as an instrument in evaluating student progress. The spirit master book consists of a four-part test for each of the 30 chapters in ***CHEMISTRY: A MODERN COURSE.*** The four sections of each chapter test include:

Discovering Concepts—A set of multiple choice questions in which students demonstrate their ability to recall specific facts from the chapter.

Interpreting Concepts—A set of completion and matching items in which students demonstrate their ability to interpret basic concepts.

Using Concepts—A set of problems and/or essay questions which require students to apply their basic knowledge to related situations.

Completing Concepts—A set of completion items in which students demonstrate their understanding of chemical terms used in context.

The major focus of each test is to help students improve their knowledge of chemistry. Using these tests as a diagnostic tool you can decide what supplemental materials may be needed to help overcome any weaknesses in presentation and instruction which may become apparent.

USING CHEMISTRY: A MODERN COURSE

Organization and Sequence

The *TEACHER'S ANNOTATED EDITION OF CHEMISTRY: A MODERN COURSE* is divided into two sections—the Teacher's Guide having grey edges along the pages and the red overprinted Pupil's text.

The Pupil's text is divided into 30 chapters. Each chapter is further divided into numbered sections. The numbering and headings of the sections aid students in locating specific topics and assist you in arranging class and homework assignments.

Chemistry: A Modern Course follows a logical, sequential development of major chemistry principles. The text begins with the "mechanics" of chemistry, the mole concept, and the structure of matter. The text then deals with the behavior of matter in terms of acidity, oxidation-reduction, and electric potential. It also includes descriptive material in nuclear, organic, biochemistry, and analytical chemistry.

Teacher's Guide

Overview

This section provides you with a short synopsis of the major themes of the chapter. You are also given an insight as to how the chapter material fits into the overall sequence.

Demonstrations

Good teacher demonstrations are important in helping students visualize abstract concepts and allow for the development of observational skills and proper lab techniques. Use the demonstrations in the text to emphasize safety rules and procedures. The approach you use in presenting a demonstration can be one of the following: begin with a clearly defined problem or use the demonstration as a silent type where your goal is to develop students' ability to observe and draw conclusions. These skills will be critical to their success in the laboratory portion of the course. Good demonstrations allow students to recognize and verbalize relationships based on their level of experience. The demonstration as a teaching technique allows you to present a maximum amount of text material in a concrete and visual manner. You will find numerous demonstrations printed in red throughout the Pupil's text. Any additional preparation and teaching strategies will be covered in the Teacher's Guide section for that chapter.

Performance Objectives

The major Goal of the chapter is followed by a list of specific objectives. Thus, you are aware of the points to emphasize in covering the chapter. When designing your chapter tests or course of study for beginning chemistry use these objectives as a framework. The Evaluation Program which is part of the Merrill Chemistry Program is written based on the chapter objectives. A thorough explanation on how to use performance objectives is found on pages 22T-24T.

Teaching Techniques

Section teaching techniques are provided when appropriate. These strategies include information concerning the authors' approach to a particular topic, additional science background, and suggestions as to how to achieve a better level of success in presenting a section to students.

Problem Solutions

Answers to most problems are found in red overprinted on the Pupil's page for convenience. However, note that some answers would not fit in the existing space on a page. The Teacher's Guide contains full solutions for all questions and problems in the Pupil's text.

Teacher Annotations

The red Teacher Annotations consist of answers to problems, demonstrations, science background, points of emphasis, and teaching strategies. They are conveniently located with the appropriate text material.

Pupil's Text

Readability

Readability plays a major role in determining the success of a textbook in the classroom. A text which can be comprehended by the majority of students promotes their interest and involvement in the subject area. This feature promotes teachability and helps facilitate classroom management.

In controlling reading level, careful attention has been given to vocabulary, sentence construction, paragraph structure, chapter organization, illustrations, and text format.

The vocabulary in the text is consistent with the developmental level of average high school students. Words with a large number of syllables have been avoided whenever possible. In addition, important science terms are printed in boldface or italic type when first presented. Some terms are followed by their phonetic spellings. Each term is then clearly defined and used repeatedly throughout the discussion to reinforce its meaning.

The open format is the result of appropriate spacing between sections, problems, and illustrations. The typeface and size in which the text is set is another aspect that enhances readability. The margin is used for supplemental information in the form of margin notes, captions, and annotations. Thus, the flow of ideas in the main body of the text is not disrupted. Highlighting and organizing important information using boldface type, student notes, tables, and Summary statements also enhances readability.

Photographs and Illustrations

We maintain that a visual presentation not only motivates students but certainly adds to their level of understanding. The use of material which provides students with visual links between chemistry principles and real-world happenings is a vital part of the learning process. Each chapter opening consists of a color photograph and a thought-provoking paragraph designed to stimulate student interest in the material to be presented in the chapter. In addition over 450 color photographs, illustrations, and graphs are included throughout the text to reinforce and clarify concepts presented in adjacent paragraphs. Use these graphics as part of your presentation as much as possible so students learn to think of them as an active part of the text.

Example Problems

Example problems are used extensively to present the mathematical concepts needed in studying chemistry. The factor-label method of problem solving is used and unit cancellation lines are printed in blue to aid students in setting-up problems. The Example problems provide students with clear, logical models they can use to achieve an answer. Each Example problem is titled and set-off from the body of the text for quick reference. Take the time in your presentation of a section to thoroughly review each Example with students.

Student Notes

Student notes are placed in the margin to aid in review. Using the section titles as a framework, these notes can be used to provide students with a ready outline of the concepts discussed within the chapter. They are also an excellent reading aid in providing students with a concise statement of a paragraph or concept.

Chemical Careers

These features are designed to give students an awareness of the many fields which draw on a knowledge of chemistry. These features should be used to emphasize the importance of this subject in students' overall education. Use the features as a starting point for students to do additional research into the many career options available. Emphasize that a doctorate in chemistry is not necessary to pursue a chemistry-related career. A basic chemistry course is adequate preparation for many jobs.

Chemical Technology

These features present supplemental discussions of chapter concepts and insights into current research problems. These pages should be used to motivate students to seek additional information concerning timely issues such as the use of scarce resources, energy alternatives, progress, and the environment. Some features highlight an additional application of some topic within the chapter. Thus, students are aware of how our knowledge of topics such as crystal structure, distance measurement, and ion activity was formulated.

Biographies

Each chapter includes a short biography of a scientist whose work has contributed to the principles presented in that chapter. The Biographies are designed to bring out the human aspects of scientists in general and to relate their work to the relevant problems of their times. In using the Biographies be sure to emphasize that many great scientists had to overcome numerous obstacles in the pursuit of their work.

Section- and Chapter-End Materials

Questions and problems follow many sections of the text. They are designed for students to check their understanding of the previously covered material. Answers are provided in blue for some questions and problems within a chapter to allow students to gain confidence in the mastery of new material.

The chapter-end materials begin with a Summary which concisely reviews the major concepts and principles in the chapter. Each Summary statement is numbered and keyed back to the chapter by a blue student note. You can begin the chapter using the Summary to determine how much your students know about a topic from previous science courses. The Summary is an excellent reading aid in that it helps students discern the important points from the mass of material in the chapter. It also gives you an insight as to the points the authors feel should be emphasized in presenting a chapter.

The Problems section provides questions and problems to review the major concepts of the chapter. Students' success depends greatly on their being given the opportunity to develop math skills and apply their chemical knowledge to new situations. Having students answer these items and then thoroughly reviewing each with them should be adequate preparation for a chapter test.

The Review section provides questions and problems where students recall the important principles and concepts from previous chapters. Since many topics in this text build on the knowledge gained in a previous chapter, this section provides an excellent way of unifying information. It also gives students additional practice in problem solving and applying concepts.

The One More Step section presents questions and activities to lead students beyond the material covered in the text. This section is designed to provide a number of open-ended activities. Use these items to develop positive attitudes toward science, as extra credit projects, or as a means of individualizing the course for students having the ability to digest material at a higher level than that presented in the text. Note that these items provide for a wide range of activities from simple library research to designing a technical research problem. Thus, they can be assigned to students at all levels of ability.

The Readings provide interested students with references to expand their knowledge of some aspects of the chapter. Encourage students to read articles concerning science in the local newspaper and popular news magazines. At this point in their education you want to establish the idea that a study of science is not relegated to the classroom or laboratory. The success of new science magazines for the nonscientist exemplifies this idea.

Appendices

Appendix A contains twelve useful tables to provide students with all the necessary data to work the problems in the text. This comprehensive set of tables provides you with all of the necessary reference data in one volume.

Appendix B contains a section to review the use of logarithms in chemical calculations. A table of logarithms follows this review section.

Appendix C contains a partial listing and description of some chemistry related careers.

Glossary

The Glossary provides students with a quick reference to the key terms presented in the text.

PLANNING GUIDE FOR *CHEMISTRY: A MODERN COURSE*

You are in the best position to design a chemistry course that meets the needs of your students. You will find the arrangement of ***Chemistry: A Modern Course*** allows for a certain amount of flexibility in planning. You may prefer to use the chapters in a different sequence to reflect your own philosophy of teaching chemistry. For example, if you prefer a historical approach, use Chapters 1, 8-18, 2-7, and 19-30 in that order. We have arranged the text so as to provide a background early in the course that permits a strong laboratory approach. This planning guide is provided to assist you with both long range and daily planning. We hope it helps in designing the best possible chemistry program.

The guide is organized to present a suggested number of class sessions for each chapter. The entire course is based on 180 class sessions in the school year, which is equivalent to 160 hours of combined class and laboratory time.

The sections of each chapter are classified as being of primary or secondary importance. We believe that a basic chemistry curriculum must include those sections designated as primary importance. The sections listed in this category provide a minimum program. After presenting the essential sections in each chapter, you may have the time to select from additional text topics and laboratory experiments. The planning guide shows the correlation between the experiments in ***Laboratory Chemistry*** and the content of the text.

The first sixteen chapters are considered to be the equivalent of a semester of study. You will want to complete them in 90 class sessions. We consider the first 27 chapters to be essential in an introductory high program which is designed to survey chemistry and prepare students for further study in science.

Once you have determined your goals for the year, use this guide to aid you in scheduling. The number of class sessions suggested includes time for laboratory experiments and testing. You may find that some classes will take longer to cover a chapter than what is projected in the planning guide. Use the planning guide as a framework not as a rigid schedule that must be adhered to.

The following is a general guide to covering the chapters if you are on six or nine week reporting periods.

Six Week Periods	Chapters
First	1–6
Second	7–11
Third	12–16
Fourth	17–20
Fifth	21–25
Sixth	26–30

Nine Week Periods	Chapters
First	1–8
Second	9–16
Third	17–23
Fourth	24–30

Correlation for supplemental problems in *Solving Problems in Chemistry* © 1983

Chemistry: A Modern Course	***Solving Problems in Chemistry***
Chapter 2	Chapter 1
4	2
5	3, 4, 5, 6, 16
6	7
7	8
17	14
18	9
19	10, 11, 12, 13
20	15
21	16, 18
22	19
23	17
24	20
25	21, 22, 23
26	24
27	25
28	26
29	27

PLANNING GUIDE FOR *CHEMISTRY: A MODERN COURSE*

Chapter	Class Sessions	Emphasis Level Of Primary Importance	Emphasis Level Of Secondary Importance	Suggested Experiments from *LABORATORY CHEMISTRY*
1	3	1:3–1:5	1:1, 1:2	Laboratory check-in OBSERVING, INVESTIGATING, ANALYZING, INTERPRETING: SCIENTIFIC METHOD INVESTIGATING THE LAW OF CONSERVATION OF MASS-ENERGY
2	5	2:1–2:7	2:8	INTRODUCTION TO QUANTITATIVE MEASUREMENT: DENSITY DETERMINATION
3	4	all sections		CHEMICAL AND PHYSICAL CHANGES IN MATTER
4	5	all sections		CHEMICAL FORMULAS AND OXIDATION NUMBERS
5	6	all sections		QUANTITATIVE DETERMINATION OF AN EMPIRICAL FORMULA HYDRATED CRYSTALS
6	5	all sections		CHEMICAL CHANGES AND EQUATIONS
7	10	7:1–7:4	7:5–7:7	QUANTITATIVE STUDY OF A REACTION MOLE RELATIONSHIP IN A CHEMICAL REACTION SPECIFIC HEAT OF A METAL HEAT OF A CHEMICAL REACTION
8	7	8:6–8:10 8:13–8:14	8:1–8:5 8:11–8:12, 8:15	FLAME TESTS INTRODUCTION TO THE SPECTROPHOTOMETER ENERGIES OF ELECTRONS
9	8	9:5–9:15	9:1–9:4	ELECTRON ARRANGEMENTS
10	7	10:2–10:13	10:1	THE PERIODIC LAW INTRODUCTION TO QUALITATIVE ANALYSIS
11	3		all sections	THE ACTIVITY OF GROUPS IA, IIA, AND VIIA
12	6	all sections		ENERGY RELATIONSHIPS OF METALLIC IONS CONDUCTIVITY AND CHEMICAL BONDING
13	8	13:1–13:8	13:9–13:12	SHAPES OF COVALENT MOLECULES AND POLARITY
14	4	14:1–14:2	14:3–14:11	INTRODUCTION TO CHROMATOGRAPHY
15	5	all sections		