

STUDY GUIDE FOR  
**COLLEGE CHEMISTRY**  
**AND GENERAL CHEMISTRY**

SEVENTH EDITIONS

BY HOLTZCLAW, ROBINSON, AND NEBERGALL

NORMAN E. GRISWOLD



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**NORMAN E. GRISWOLD**

*Nebraska Wesleyan University*



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AND  
GENERAL CHEMISTRY**

HOLT, RINEHART & WILSON

NORMAN E. GRISWOLD



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# PREFACE

This Study Guide has been prepared as an aid to students using *College Chemistry*, Seventh Edition and *General Chemistry*, Seventh Edition by Holtzclaw, Robinson, and Nebergall. The guide is intended to supplement the texts or the lectures of the instructor and to provide guidance to students as they study corresponding chapters in the textbook.

The first 29 chapters in both *College Chemistry* and *General Chemistry* are identical and are treated on pages 7-231 of the Study Guide. Pages 232-268 contain the material for Chapters 30 through 35 of *College Chemistry*, and pages 269-310 relate to Chapters 30 through 38 of *General Chemistry*. The format of each chapter in the Study Guide is explained in the section titled "To The Student."

The author wishes to express his thanks to W. R. Robinson, Purdue University, and H. F. Holtzclaw, Jr., University of Nebraska—Lincoln, for making the manuscripts of the new editions of the textbooks available and for being receptive to questions and comments. Sincere appreciation is also expressed to the staff of D. C. Heath and Company for their constructive criticism and help during the writing of this book. Finally, much love and gratitude must be expressed to my wife, Ruth, and our daughters, Diane and Debra, who have endured my writing sessions with patience and understanding.

Norman E. Griswold

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# TO THE STUDENT

This study guide was written to help you, the student, to study and understand introductory chemistry at the college level. It was written specifically for use with either the Seventh Edition of *College Chemistry*, by Holtzclaw, Robinson, and Nebergall, or the Seventh Edition of *General Chemistry*, by the same authors. (In this Study Guide, these books will be referred to as "the text.")

When you start using the guide you will quickly discover that it is not a substitute for the text; that is, it does not condense the contents of each text chapter so you can cut down on reading time. Rather, it directs and assists you in your study of the text. If you have never studied chemistry, you will undoubtedly find it hard to recognize which points are important, to understand how some topics relate to others, and to decide how best to study certain material. This Study Guide tries to help along these lines; in addition, it offers a convenient means of checking your understanding by providing Self-Help Tests, with answers.

The Study Guide begins with a section about general study methods. The suggestions are based on the author's experience as a student and a teacher and on his conclusions from observing the study habits of students over many years. As mathematical calculations are a vital part of the study of chemistry, the guide includes brief directions for solving problems.

The main body of the Study Guide is divided into chapters that correspond to chapters in the text. Each chapter in the guide contains sections called Overview of the Chapter, Suggestions for Study, Words Frequently Mispronounced, Performance Goals, and Self-Help Test.

## OVERVIEW OF THE CHAPTER

The Overview contains a brief description of the chapter's contents, with some of the more important subjects and terms set in boldface type. This section normally should be read before studying the corresponding chapter in the text.

## SUGGESTIONS FOR STUDY

This section gives suggestions for special study emphasis, correlates some topics with those in previous chapters, and points out potential difficulties or misunderstandings that may arise and how to avoid them. Suggestions are arranged in the order of appearance of the corresponding text topics and references are given to the specific text section being considered.

## WORDS FREQUENTLY MISPRONOUNCED

This section appears only when pronunciation aids seem necessary for some of the technical words and names of scientists used in the text chapter. With each word, there is a reference to the section in the text in which the word first appears.

Pronunciation aids are provided in the form of a phonetic system. The following examples illustrate use of this system.

Pronunciation Aid	Common Word with Same Sound
a	add
ah	not
ay	say
ee	feed
eh	bet
ie	tie
ih	fit
oh	no
oo	food
ow	how
uh	run

When using this system, consonants should be pronounced in their most common way. For example, the letter *g* in a pronunciation aid should be pronounced as in *gun* rather than as in *gentle*. An effort has been made throughout to avoid ambiguity in pronunciation.

An index for all words appearing in these sections in the Study Guide can be found on the last few pages of this book.

## PERFORMANCE GOALS

This section points out the rules, laws, and concepts that must be memorized and indicates the types of calculations that you should be able to perform. Although some memorization is necessary in general chemistry, it is not stressed. Thus, this section describes only the most essential things to be memorized. Where possible, appropriate text questions and questions from this Study Guide are indicated to help you check your performance.

## SELF-HELP TEST

Over 1700 questions of the true-false, multiple-choice, completion, and matching type are given in this Study Guide. While this short-answer format may not be the best, or the most common, form of testing in general chemistry, it does make it possible to use these questions as a quick check of your mastery of chemical theories and concepts presented in the text. The Self-Help Tests contain very few numerical problems; the text has this type of problem (with answers) at the ends of the chapters. Answers to all questions in the Self-Help Tests are supplied in the guide, and in many cases, the answers are accompanied by brief explanations.

It is hoped that in this course you will derive not only a basic knowledge of the facts and principles of chemistry but also an interest in scientific inquiry and investigation. If this Study Guide can play even a small part in stimulating your interest, its purpose will have been served.



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# INTRODUCTION

## SOME COMMENTS ABOUT STUDY METHODS

Like many students, you may find that advancement to college-level courses requires a change in study methods. This need for change comes from a combination of factors. To begin with, the competition among students for high marks is usually more intense in college-level courses. Also, because of the large amount of information presented in college-level courses, students are generally expected to do much learning on their own. As a result, the courses seldom meet every day of the school week. This eliminates the daily chance for the instructor to remind you to study and results in less classroom exposure to the course material. If homework is assigned, it is often either not collected or not graded. In fact, grading in college-level courses may be based largely on the results of two or three written examinations rather than on class attendance or many daily exercises and assignments.

It is also true that entry into a college or university often changes your study situation itself. Studying in a noisy, crowded dormitory is quite different from studying at home. Such a situation provides a convenient excuse for postponing study or even not studying at all. School activities such as parties and sports events provide additional excuses for not studying. Another factor pertinent to college-level courses in chemistry is that the classes are often large. This may allow you to seek the refuge of anonymity, which makes it hard for the instructor to recognize that you are having difficulty until it is almost too late.

You must recognize all of the changes in the course-taking situation early and must cope with them as soon as possible. This requires constant self-evaluation and subsequent changes in individual study methods and calls for the self-discipline necessary to keep up in college-level courses. *The key to success in a college-level chemistry course is regular study. Regular study means every day, if possible.* Putting off study until just before an exam usually leads to a series of all-night ordeals — a procedure that can only result in limited success and possibly disaster, especially when two or more examinations are scheduled for the same day. All-nighters are hard on your

health, providing only temporary memorization and seldom any long-range learning. (Don't forget the final exam!)

The following general suggestions are for developing good study methods in the college introductory chemistry course. Students are individuals, so these suggestions may need to be adapted to your individual needs.

### Study Methods for Introductory Chemistry

Introductory chemistry courses are generally taught by the lecture method. Ideally, you should read the topics for each lecture before class time to get a general idea of the material to be covered and to determine potential areas of difficulty. Prior study should, in addition, enable you to listen to the lecture much more intelligently. In most cases, the instructor expects you to read ahead, and he or she will present the lecture with the assumption that you have done so. An added advantage of prior study is that it becomes unnecessary to take extensive notes; you will know what lecture material is contained in the text. Studying before class also helps you recognize the information that the lecturer seems to consider important and that may be covered in forthcoming examinations. Take your text to class and keep it open to the topic being described, if possible.

Obviously, it is advantageous to study the lecture material in detail as soon after class as possible, while the explanations and ideas are still fresh in your mind. Clarify the notes you have taken where necessary, and concentrate on the topics you found difficult to understand. When you are reading the text, pay close attention to words and statements in italics or boldface type. Throughout, concentrate on understanding concepts rather than memorizing everything. Knowing some facts and definitions is necessary for successful completion of any science course, but the concepts give the facts meaning.

If, after studying, you have trouble understanding certain topics, don't hesitate to ask questions during the next recitation-quiz session. Try to phrase your questions so it is clear to the instructor that you have made some effort on your own. If your course does not have recitation-quiz sessions scheduled, make an appointment to see the teaching assistant or the instructor. Try to avoid saying such unhelpful things as

"I read the chapter six times!"

"I don't get any of this!"

"I am totally lost!"

or other similar comments. Instructors know that the depth of learning is not necessarily directly proportional to the number of readings. Try to pinpoint the specific area of difficulty as much as you can, so your appointment can be used efficiently. When you have finished a part of the chapter, work some text exercises (they are divided into groups by topic, to help you find the appropriate ones). Treat these exercises as examination questions; try to work them without looking at the text material or your notes. This is good practice for taking examinations.

### Using the Study Guide

In using this Study Guide, you will benefit by briefly reading the sections called Overview of the Chapter, Performance Goals, and Words Frequently

Mispronounced before you begin studying the corresponding chapter in the text. As you study the text, you can then refer to the Suggestions for Study for more specific details. This Study Guide emphasizes the principles and concepts of chemistry rather than the problems, so be sure to work as many of the text exercises as you can; this practice will add greatly to your understanding of the concepts.

After you think you have mastered the material in the text chapter, take the Self-Help Test for that chapter. Treat this test as a self-examination, answering as many questions as you can without the text or notes. After checking your answers, you should go back to the text for the information needed to answer those you missed. The Self-Help Test provides an easy way for evaluating your mastery of the topics in the chapter. A couple of hours spent in this way for each chapter is good training for examinations.

## Solving Problems

Probably the most important prerequisite for taking a general chemistry course is facility in reading at a reasonable rate with comprehension. A close second, however, is the capability for using simple mathematical operations for solving problems. These operations usually include multiplication and division and, occasionally, taking square roots. You will also need to use (1) exponential notation for representing very small or very large numbers, (2) the rules of significant figures for indicating the accuracy of measurements, and (3) logarithms in certain chemical expressions. Explanations and examples concerning exponential notation, significant figures, and logarithms are in Chapter 1 and Appendix A of the text.

Much of your study time should be spent in working numerical problems related to chemistry. Make a regular habit of working such problems, even if they have not been assigned; try to work a few every day. All the numerical problems in the text have answers to help you check your work. In addition, selected problems are worked out in detail in a specially prepared manual called *Problems and Solutions for College and General Chemistry, Seventh Edition*, by Holtzclaw, Robinson, and Nebergall, prepared by Meiser, Ault, Holtzclaw, and Robinson and available from the publisher, D. C. Heath and Company. If you don't have time to work all the problems at the end of a chapter (some chapters provide more than 50), select randomly an appropriate number of them to work completely, and read through those remaining to see if you can decide quickly on a general method for solving them.

Regular attention to working problems in this course not only will strengthen your knowledge of chemistry but also will help you to develop an ability you will need throughout your life — an ability to solve problems. While most of your life problems will probably not be of a chemical nature, any kind of problem-solving relies on careful analysis and logical thought, which can be acquired only by practice. You can improve your general problem-solving skills through constant practice with chemistry problems.

The following suggestions may help you if you are inexperienced at solving problems in chemistry. First, you should understand that you may not be able to determine the solutions to these problems instantly, just as you were probably not able to ride a bicycle instantly. Second, if you do not quickly see how to solve a particular problem, try to analyze it carefully by asking yourself questions such as the following. (Specific sample problems solved by this means will be in the Suggestions for Study of Chapters 1 and 2.)



1. What is the problem asking me to calculate?

There is no point in proceeding with the problem unless you can answer this question unambiguously.

2. What information is supplied?

Often it helps to write down the numbers given in the problem along with appropriate symbols and units.

3. What relations do I know that involve the items in Questions 1 and 2 above?

This is the crucial part. The emphasis here is on the word *know*. If you find yourself flipping from page to page in the text seeking the answer to this question, your study is probably incomplete, and you may not be ready to solve problems yet. Study further the areas under question before continuing with the problems. The answer to this question may involve one relation or perhaps two or three.

4. Is anything missing?

For these problems to be solvable, numbers must be available for all necessary terms except the one being sought (the one in Question 1 above). If something is missing, you may have overlooked a relation or perhaps the value of a constant, which may be given in the chapter itself or in an appendix.

5. Are all data in the proper units?

To answer this question, try dimensional analysis, that is, carry the units along in the calculation and see if they give the proper units for your answer.

Example. Calculate the number of centimeters in 1000 mi. From your earlier schooling, you probably recall the following relations:

$$\begin{aligned}12 \text{ in} &= 1 \text{ ft} \\5280 \text{ ft} &= 1 \text{ mi}\end{aligned}$$

and in Chapter 1 you will learn that 1 in = 2.54 cm. These numbers must be put together in such a way that the result is in centimeters. The solution is

$$\text{cm} = 1000 \cancel{\text{mi}} \times \frac{5280 \cancel{\text{ft}}}{1 \cancel{\text{mi}}} \times \frac{12 \cancel{\text{in}}}{1 \cancel{\text{ft}}} \times \frac{2.54 \text{ cm}}{1 \cancel{\text{in}}}$$

All the units on the right-hand side of the equation cancel algebraically except the unit of centimeters. Therefore the result shown is calculated in the proper manner. The dimensions (mi, ft/mi, in/ft, and cm/in) help decide what mathematical operation is correct; this is dimensional analysis. (See Section 1.9 in the text.)

6. Can the problem be solved now?

If all terms are present and in the proper units, it should be possible to finish the problem and obtain the answer. If your answer does not agree with the answer given in the text, check your arithmetic first.

One of the most important aids to your study of chemistry is a hand calculator. If you don't already have one of these, get one immediately, and learn to use it as soon as possible. The time saved by using a calculator in chemistry alone will be well worth the money spent to obtain it. At first you may hesitate to trust the results obtained by using these instruments, but with practice you will become proficient, and with proficiency will come

confidence. Start using the calculator in Chapter 1, where the arithmetic is simple. See if you can obtain the same numerical answers for the worked-out examples as the text gives. Then use the calculator to work the problems at the end of the chapter, again checking your work against the answers in the text. Gradually, your confidence should increase, and you will rely completely on the instrument.

## TAKING EXAMINATIONS

Whether you find chemistry difficult or not, there are some ways of taking examinations that can help you get higher scores. First, try to come to the exam in a calm state. Considerable help in achieving this condition can be gained by using the study method suggested previously, by getting adequate sleep the night before, and by avoiding last-minute efforts to cram new ideas into your head. When you receive the test, put your name in the appropriate place(s) and listen to or read the directions carefully. Then begin to read through the test. Stop to answer only those questions for which you *definitely* know the answers. If you come to one you can't answer readily, pass it by and come back later. Don't sit and ponder. You will only waste valuable time. After you have answered all the easy questions, attempt the others. Start with the questions that count the most on the final score.

Most examinations in chemistry contain problems, and training yourself to work them rapidly is important to success. On most problem-type questions, your professor usually will be more interested in the methods you use toward solutions than in numerical answers. Therefore, set up the problems in a form such as the following:

$$\text{Density of the ore} = \frac{0.215 \cancel{\text{ lb}} \times 454 \text{ g}/\cancel{\text{ lb}}}{18.2 \text{ cm}^3} = \frac{\text{g}}{\text{cm}^3}$$

Don't work out the final numerical answers until you have finished with the other parts of the test.

If you feel yourself getting tense as you work, stop, close your eyes, stretch your muscles, and try to relax for a full minute. Then go back to work and do the best you can. If you finish before the end of the period, use the remaining time to check your answers.

When the examination is over, try to find out the correct answers to the questions while they are still fresh in your mind. Some professors make answer sheets available immediately after an exam, or you may obtain answers from the text or from other students. In other words, try to straighten out immediately any difficulties you may have had, so that they don't recur. Remember, also, that the course continues after the exam; don't let yourself get behind by taking a post-exam vacation from study.

## SUMMARY

The following suggestions about study methods summarize this section.

1. Evaluate constantly the effectiveness of your study methods.
2. Study regularly (every day, if possible).
3. Read the material before the lecture.

4. Study hard after each lecture.
5. Use this Study Guide to aid learning.
6. Ask questions.
7. Work as many problems as you can. (Use a hand calculator.)
8. Give yourself practice exams.
9. Follow recommendations for getting the best results in an examination.

# 1

## SOME FUNDAMENTAL CONCEPTS

### OVERVIEW OF THE CHAPTER

The first part of Chapter 1 (Introduction) describes what chemistry is and some of the branches into which it is divided, how chemists solve problems, some basic language that chemists use, and a few of the challenges they face. The last part of the chapter (Measurements in Chemistry) describes common units of measurement for length, volume, mass, density, temperature, and heat. It also explains unit conversions (using dimensional analysis), uncertainty in measurements, and significant figures. It is crucial to master the concepts and terms presented in this chapter because they are fundamental to a study of chemistry and will be used extensively throughout the text.

### SUGGESTIONS FOR STUDY

It is extremely important to start your regular study as early as possible; you must never fall behind. If at all possible, read the text through Section 1.3 before you attend the first class. This part of Chapter 1 gives an idea of the scope of chemistry and its relation to some of the developments and problems of society. Then continue as soon as possible after the first class with the rest of the introduction, using Performance Goal 1 as your guide for basic study. Some of these concepts are probably familiar already, so one careful reading may be sufficient for understanding.

After you've read the introductory part of Chapter 1, try to answer Text Exercises 1 - 15 and Self-Help Test Questions 1 - 28 to check your understanding. Remember that a science text cannot be read with the same speed as, for example, a novel, so don't be impatient if the going seems slow.

Performance Goals 2 through 4 are applicable to the part of Chapter 1 on measurements in chemistry. It is essential to become familiar with units of the metric system because it is used extensively in chemistry and is found throughout the text. Try to gain a feeling for the actual sizes of units of