Student's Guide to

Second Edition

Introduction to Chemical Principle

BERLOW

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Second Edition

Introduction to Chemical Principles

by Edward I. Peters

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TO THE STUDENT!

The purpose of this Guide is to HELP YOU SUCCEED in your first college chemistry course. Every student who enrolls in introductory chemistry can master the methods and concepts; the words, symbols, and arithmetic used by chemists to explain what they see in the world about us.

Each of the nineteen chapters in the Text, Edward Peters' *Introduction to Chemical Principles, 2d edition*, corresponds to one CHAPTER in this Guide. Several of the Guide chapters are further divided into subchapters (Part A, Part B, ...) to make your studying easier. You should begin each Guide chapter by reading the INTRODUCTION, which gives you a brief idea of what you will be learning, why it is important for you to understand the concepts and methods involved, and how the new material relates to what you learned in previous chapters. Some of these introductions may increase your interest in chemistry, and bring out its relevance to the substances you encounter at home or read about in the newspapers.

Each chapter or part then contains:

- a STUDY CHECK-LIST of things you should do, in order to learn the material;
- a DISCUSSION of some of the more important points to remember in the reading;
- a SELF-TEST which helps you find out how well you have learned the concepts and methods of the Text, and how far you have progressed towards the Performance Goals of the chapter;

At the end of each chapter are ANSWERS AND REVIEW REFERENCES for all Self-Tests of the chapter, which provide detailed solutions to the questions you answer and "send you back" to specific pages, Text Examples, and illustrations if further review is needed.

You will find the Text to be clear and readable. It is a highly effective learning resource, and it contains many special features, such as Performance Goals, self-tutoring Examples, Chapter Reviews, and over 500 solved problems, that make your learning process as easy as possible. You may possibly need some help and encouragement at times, however. Some of the ways that chemists look at matter and

energy may seem strange; some of the problem-solving may look difficult. But if you approach the subject systematically, and if you are willing to do some work, you will succeed.

Your instructor will do everything possible to help you learn the material and overcome any difficulties. This Student's Guide (*your Guide*) will help you plan and check your progress towards mastery of the basics of chemistry.

STUDY CHECK-LIST - We suggest that you make a check (✓) as you complete each part of the studying process. First READ the Text assignment fairly quickly, to get an overall feel for what you will be learning. Then study each Text section carefully, highlighting points to which you will wish to refer when the time comes to review for a test. GUIDE your study with the Performance Goals at the beginning of Text Sections (and repeated for your convenience in the summary at the end of each Text chapter). PROGRESS through the Text Examples (if any) using an opaque sheet to cover the answers until you have gone through the thought processes needed by yourself. COMPLETE a set of end-of-chapter Text Problems, and COMPARE your answers with the detailed solutions at the back of the Textbook.

Notice that both the Text and this Guide use many *page references* to guide you to the exact spot where information can be found. To avoid confusion, we will here use *circled numbers*, such as (79) and (201) when we refer to pages in this GUIDE, and *uncircled numbers*, such as 173 and 59 to refer to pages in *Introduction to Chemical Principles, 2d edition*.

After completing your study of the Text sections, read the DISCUSSION that follows the Study Check-List and take the SELF-TEST. This painless manner of evaluating what you know should provide you with the confidence you will need to do well on tests and exams. Pretend that the Self-Test is a serious classroom quiz by taking it to a quiet place where you will not be interrupted or distracted. Write out your best answer to each question, including your reasoning as well. As a general rule, how you obtained the answer is more important than your getting the exact wording or numbers right. Do not look at the Text or other parts of the Guide until you are done. Some Self-Test questions are marked with an asterisk (*) which means (as it does in the Text) that the questions go somewhat beyond the minimum Performance Goals of the chapter.

After completing all of the questions in a Self-Test, refer to the ANSWERS AND REVIEW REFERENCES. If your answer and method are correct, great! You have thus confirmed what you probably suspected, that you have indeed mastered that aspect of chemistry. You should be able to answer any test or laboratory question based on

the same Performance Goal. If you had difficulty with a Self-Test question, or if you were a bit unsure of your understanding of the topic, use the REVIEW REFERENCES which tell you exactly where to find the Text coverage of that material.

The STUDY CHECK-LIST ends there. The rest is up to you. Students vary greatly in the time, effort, interest, motivation, and background they bring to the study of chemistry. If you find that you are learning the course material very easily, then perhaps an hour each week (in addition to your study of the Text) will suffice to go through the Self-Tests and check the answers. If you make sure, in that way, that you have truly studied the material effectively and have gained enough practice, then you are unlikely to "freeze" on an exam and forget what you learned.

If, like some students, you tend to "flounder around" while studying, this Guide will steer you towards more effective study habits. When you take the Self-Test, you will find out exactly where you are weak, and you can concentrate on mastering what you do not already understand.

Most of the students using this Guide are in traditional college classroom settings, with teachers available to answer questions and to provide practical examples. In the following pages, you will find a special emphasis on the way chemistry is used in our modern technological society. We hope you will learn to look at food and drug labels, at fabrics and paints, in a different and more knowledgeable way. Don't be afraid to discuss any questions that come to mind with the instructor. In that way, you will perhaps be able to share some of the excitement and curiosity scientists feel about chemistry.

A particularly well motivated student may use the Text and Student's Guide as a self-study package, since they are both designed to help each individual student. An important part of your study of chemistry is LEARNING HOW TO LEARN. We hope the study skills you develop here, in this course, will be useful to you in later work in chemistry and in other fields. We know that success breeds more success. It is important to start out right in your study of chemistry, and build up your understanding bit by bit. You are now ready to start with CHAPTER 1 on page (1).

PREFACE

The Student's Guide to Peters' *Introduction to Chemical Principles, 2d edition* provides a framework for effective studying and assists the introductory chemistry student to overcome some of the most common learning difficulties. It organizes the various features of the Text into a recommended study scheme (provided by a STUDY CHECK-LIST for each topic) so the student's time may be structured to avoid omissions and wasted effort.

The DISCUSSIONS in this Guide are not intended to explain and summarize the points made in the Text, since the Text presentation is clear and concise. There a student will find many learning aids, such as Performance Goals (objectives), semi-programmed examples, and several very extensive drill exercises. More than 550 problems and questions are accompanied by full answers and, for numerical problems, detailed dimensional analysis set-ups. The Text also provides full chapter review sections, with lists of new terms and summaries of objectives, to aid the student studying for an exam.

Therefore, an effort is made in this Guide to point out how the student may avoid some frequently encountered errors and pitfalls, and to restate in outline form the steps in certain important problem-solving methods.

Each SELF-TEST is intended to be diagnostic and motivating for the student. All answers require thought, and most involve the complete setting-up of a problem or a short paragraph of explanation. There are very few multiple-choice or true-false questions because the intent is to steer the student away from guessing answers and towards a real understanding of the concepts and methods being learned.

The ANSWERS AND REVIEW REFERENCES are detailed and explanatory. Answers to numerical problems include full set-ups, following the approach of the Text. Anyone who has difficulty is referred to the exact page, diagram, example, or Performance Goal that will be of greatest value in reviewing the concept in the Text.

Thus, unlike some "programmed" supplements, this Guide does not force any student to waste valuable time reviewing course material which has already been mastered. It functions more like an "advisor" concerned with the discovery and removal of barriers to full understanding of the course material.

Each major topic and all Performance Goals from *Introduction to Chemical*

PREFACE

Principles, 2d edition will be found in the Study Check-Lists and Self-Tests of this Guide. Ten of the nineteen chapters have been subdivided into parts so that the student may "bite off" a smaller chunk of material at a time. A few topics designated *optional* in the Text have been omitted from this Guide.

The instructor of a one-semester course will probably wish to omit several chapters of the Text. While mathematically oriented topics of Chapters 3, 6, 8, 11 and 14 should be covered in sequence, I have made an attempt to avoid cross-references to topics which an individual instructor may wish to delete.

Some instructors may wish to give examination questions which combine several Performance Goals, or which stretch the student slighly beyond the stated objective. Appropriate questions of this sort in both the Text and this Guide are marked with an asterisk (*), and may be considered optional if the student will obtain a more thorough review in the General Chemistry course to follow. Special review questions will be found in this Guide in Chapter 3, Part E; in Chapter 8, Part C; and in Chapter 14, Part C. All Self-Test questions have been chosen to be as relevant as possible to the personal experience of a college student.

Although this Guide is intended for use in a traditional lecture classroom situation, it can also form part of an independent study package, for use with a P.S.I. (Keller Plan) approach, or in a correspondence course. Contact the author for more information.

Almost every student who attempts an introductory chemistry course has a basic intellectual ability to succeed. Not all do. The student who already knows how to study effectively is not in urgent need of a supplementary guide. However, the many students who have to struggle due to inadequate background, weak motivation, or ineffective study habits may benefit from this book. The aim is to motivate these people to develop new study habits, and to master the material with confidence.

I wish to acknowledge the tremendous assistance of Ed Peters, who patiently read the various stages of this manuscript (while coping very well with the demands of 150 students and the revision of the Text), and of my colleague Klaus Dichmann who made many helpful suggestions. I am also very appreciative of the encouragement given me by my wife, Carolyn, and my daughter, Pamela, who were so patient during my many hours of exile at the typewriter.

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CHAPTER 1

INTRODUCTION TO YOUR STUDY OF CHEMISTRY

CHAPTER INTRODUCTION

What is Chemistry? Is it just a collection of facts, formulas and recipes? It is something only "brilliant" people can really understand, or is it a part of nature that affects us all?

Chemistry provides a way to design a new kind of battery to power the car of the future; or to heat homes through solar energy; or to synthesize better foods, drugs, and plastics; or to devise more potent weapons of mass destruction. We can use chemistry to detect pollution in our air and water, and to understand the origins of life. Chemistry is all of these things; neither good nor bad; neither simple nor complicated (all by itself). It is a science, with many branches and aspects.

So whatever your personal interest in chemistry, and in science, you will be expected to develop a scientific approach. The curiosity and thought you bring to your study of science is much more important, in the long run, than your ability to memorize facts and equations, or to take good lecture notes. Science uses many of the capabilities of your mind: your ability to observe, to wonder, to analyse, to design experiments, and to draw conclusions. The Prologue to your Textbook offers you some of this kind of thinking.

Do you use the scientific method in your own ways of studying? Observe yourself while you read a textbook. Are you concentrating, or is your mind wandering? Do you make sure that you understand what each paragraph is driving at, before you go on to the next? Do you think about each concept as it comes up, challenge it, and toss it around a bit in your mind? Or do you simply accept what the "book" says as something to memorize? How do you approach lectures and examinations? Are you systematic, or do you rely on good fortune?

Chapter 1 of your Textbook discusses a way to study chemistry. If you decide to follow the author's advice, you might well find the learning of chemistry to be much easier than it looks. Follow the procedures in the STUDY CHECK-LIST that follows, and then we will resume our discussion of "How to study chemistry".

CHAPTER 1: INTRODUCTION TO YOUR STUDY OF CHEMISTRY

STUDY CHECK-LIST 1 (Check ✓ off each task as you complete it.)

READ this Student's Guide, "To The Student" on pages (iii) - (v). ✓ : ___

READ the Chapter Introduction (as you have already done). ✓ : ___

READ Text (E. Peters, *Introduction to Chemical Principles, 2d ed. 1978)*

"About Bubbles in Fish Tanks— a Prologue, pages 1-4; AND ✓ : ___

Chapter 1, pages 5-8. ✓ : ___

GUIDE your study with Performance Goal PG 1 A on Text page 6. ✓ : ___

READ Discussion 1, which begins on this page. ✓ : ___

DO the Self-Test for Chapter 1, which begins on Guide page (5). ✓ : ___

CHECK your Self-Test answers with those on Guide pages (6) - (8). ✓ : ___

DISCUSSION 1

Now is the time for you to bring together all of your resources for the learning of chemistry. You have an excellent textbook, which will be called *Text* in this Guide. When we refer to Text pages, we use uncircled numbers as above. If your classroom instructor has handed out a course outline, READ IT carefully. It may contain a complete list of topics to be covered in your particular course. Some of the chapters in the Text and in this Guide may be omitted.

An outline may tell you exactly how you will be evaluated, and when. If it does not, you will find out in the first class. Be sure that you know the exact schedule of labs, quizzes, homework assignments, and examinations, so you can plan your time. Are good grades important to you? If so, make sure you understand the grading system being used in your particular course.

Your outline or assignment sheet is your reference to the material you need to study. You may possibly be told that one or several topics, not in your Text or in this Guide, will be required for your course. Although you will not have a Guide section for such topics, use the procedures you will have already learned here.

Your course probably includes lots of laboratory work. If so, you should expect to purchase a lab manual well before the first scheduled date for an experiment. Read each experimental procedure the day before you go into the lab room, so you will know what to do and what is expected of you. Each experiment probably pertains to some particular chapter in the Text; for example, an experiment involving gas laws is relevant to Chapter 11. In each such case, make a note to review the appropriate parts of the Text and of this Guide, so you will know exactly what you are doing in lab. Such preparation will save you time, too!

Does your course involve lectures? Most chemistry courses do. The lecture is an excellent way for a teacher to communicate his or her interest and enthusiasm for chemistry, to outline the important points in the subject matter, and to go over the areas which give students difficulty. However, don't expect that you will learn all of the course by listening to lectures. In fact, you are likely to learn very little unless you (a) prepare for the lecture by skimming over the chapter beforehand—(the pace of a lecture is generally rather fast; a bit too fast if you have never seen the material before and are having difficulty understanding it!)— and (b) take notes of what is *emphasized* in lecture. The instructor may be giving the course a certain orientation or "leaning" which could be important to you, since the instructor is writing the exams! You should also be able to compare lecture notes with your notes from reading the text and understand both more fully.

Remember that you will learn best by *active participation*, by writing down your questions and difficulties, by doing as many problems and questions as possible, and by thinking about what you are doing. If you have a difficulty you cannot resolve, by all means go to the instructor for help. However, bring with you enough work to demonstrate that you have tried to solve the problem, but have gotten stuck. Then the instructor can be most effective in helping you. If you simply go into the teacher's office saying "I just can't understand gases", you will both spend many frustrating minutes figuring out where your specific difficulties lie. The instructor is there to *help you learn*, but most of the work must be done by you.

Do you have to prepare for examinations? Most chemistry students do! Some do it well, by keeping up with the course, week-by-week; by resolving difficulties as early as possible (and not procrastinating or delaying work); and by reviewing notes and chapter summaries and working extra problems, in anticipation of a test. Others try to cram five weeks of study into a few nights, with mixed results. The best way to prepare for exams, in fact, is to master the material, one assignment at a time.

That brings us right back to Chapter 1 of the Textbook. Your study routine should include the right *study tools*: plenty of pencils and paper, an opaque shield for Text Examples (beginning in Chapter 3) and a simple hand-held electronic calculator [Text, pages 5-6.]

Since the Text contains Performance Goals ("PG"), you are in an ideal position to use them to guide your study. A performance goal (often called an "objective") is simply *WHAT YOU SHOULD BE ABLE TO DO WHEN YOU FINISH STUDYING*. Performance goals contain verbs like "explain," "describe," "calculate," "list," or "draw." Once you

know the performance goal, it is not difficult to predict what questions will be asked. For example, PG 4 L on Text page 90 says: "Sketch the shapes of the s and p orbitals." You know that any exam question on this topic will involve a drawing of one of the four types of regions involved. Occasionally, we will "turn around" a performance goal. For example, a test question that shows you the shape of an orbital, and asks which of the s or p orbitals is being drawn, is fair game. However, a question like "Explain why there are three different p orbitals?" is not a question based on PG 4 L. [Text, pages 6-7.]

Almost all of the Text Chapter Questions and Problems (which we shall refer to as "Text Problems") and Self-Test Questions are based on Performance Goals. All exceptions are generally indicated with an asterisk (*) in both references.

In the Chapters that involve calculations or naming compounds, you should be ready to do all Text Examples exactly as described on Text page 7. Don't peek at answers! Only you will know if you do; however, you won't learn anything that way!

The Study Check-Lists in this Guide will refer you to all of the Text end-of-chapter Problems in the *left-hand* columns, those with the black numbers. Each such problem is answered fully in a section at the end of the Textbook. Once again, do not peek at the answer before fully answering the question. The problems in the right-hand columns are testing exactly the same performance goals as those in the left-hand columns; however, no answers are given in the Text. Thus, these problems (with colored problem numbers) may be assigned by your instructor as homework. Be sure you understand the reasoning behind all solutions. [Text, pages 7-8.]

Finally, the "language" of chemistry. Not every word used in this course can be assumed to have its "common" definition. For example, in a supermarket, the word "reduced" means either brought down in price, or smaller than previously. In a chemistry course, the same word has an entirely different meaning, as you will see in Chapter 17. At the end of each Text Chapter you will find a list of Terms and Concepts introduced in the chapter, along with the number of the page where the term was first used in context. You will also find brief definitions of most of these words in the Glossary at the end of the Textbook. [Text, page 8.]

This discussion has been longer than you will find in most chapters because it dealt with additional aspects of your chemistry course, such as the course outline, lectures, laboratory, and examinations. All other discussions will relate directly to the Performance Goals of the chapter.

You are now ready to try your first SELF-TEST. Since there are no performance goals for the Prologue or Chapter 1 (PG 1 A is just to allow you to get used to the system), this Self-Test is really just for practice.

Answer each of the following questions, based on your study of Chapter 1 and of this part of the Student's Guide. In each case, think before you answer. After all, you are not hurrying to finish an hour test. You are checking your own mastery of the material, or (in this case) your own understanding of what you have read. Below each question, write down your reasoning, as well as your answer.

Continue, question-by-question, until you have completed all ten of the Self-Test Questions for Chapter 1. These particular questions are all "true or false, and WHY?" Don't just guess "true" or "false". We are more interested in your reasoning (and you should be too!) After you complete all ten questions, Q 1-1 through Q 1-10 (in this Guide, "Q" stands for "Question" and "A" for "Answer".) — then look at Guide page (6), where the Self-Test Answers and Review References begin.

SELF-TEST FOR CHAPTER 1: INTRODUCTION TO YOUR STUDY OF CHEMISTRY.

Q 1-1) A theory, such as Einstein's Theory of Relativity, or Darwin's Theory of Evolution, cannot be developed if there is no experimental data available.
TRUE or FALSE and WHY??

Q 1-2) When a theory is believed by almost all scientists, it becomes a law.
TRUE or FALSE and WHY??

Q 1-3) If a student is learning the course material with very little difficulty, then there is no reason for him or her to spend a lot of time in this Guide.
TRUE or FALSE and WHY??

Q 1-4) According to the author, the best way to study Chemistry is continuously, learning little bits at a time, instead of cramming right before an exam.
TRUE or FALSE and WHY??

Q 1-5) Effective learning of Chemistry means being <u>active</u>, using pencil and paper and thinking about what you are learning.

TRUE or FALSE and WHY??

Q 1-6) A student should <u>never</u> write or draw pictures in the textbook.

TRUE or FALSE and WHY??

Q 1-7) <u>Every</u> student, weak or brilliant, should go through the Chapter Examples in the Text, using an opaque cardboard shield to cover the answers.

TRUE or FALSE and WHY??

Q 1-8) The <u>performance goals</u> at the beginning of the Text Sections are only useful if you have difficulty with end-of-chapter problems.

TRUE or FALSE and WHY??

Q 1-9) Ability to understand and communicate in English is of considerable importance in this Chemistry course.

TRUE or FALSE and WHY??

Q 1-10) If you are unsure of the meaning of a chemical term, you should immediately look it up in a standard dictionary.

TRUE or FALSE and WHY??

Each Student's Guide Chapter ends with the ANSWERS and REVIEW REFERENCES for the one or more Self-Test(s) of the Chapter. ↓

ANSWERS AND REVIEW REFERENCES - CHAPTER 1.

A 1-1) <u>TRUE</u>. If you have experimental facts, you can build a hypothesis. If more experimental data support the hypothesis, it becomes as theory. See the Prologue, Text page 3: A theory is an <u>explanation</u> of experimental facts.

A 1-2) FALSE. A law is a simple statement of an experimental fact or relationship: "if X happens, Y is also observed." A theory attempts to explain the law. In fact, it is rather common to have two or more theories, each explaining the same observed facts or law. See "Curious Woman's Law" on page 3 of the Text.

A 1-3) TRUE. The purpose of this Student Guide is to help you, not to waste your time. If you have mastered the material, go on to the next Chapter! See "To the Student" on Guide page (v).

A 1-4) TRUE. Chemistry is cumulative; you can't understand Chapter 8 of this course if you rush too fast through Chapters 6 and 7, without really understanding them. See Chapter 1, page 5 of the Text.

A 1-5) TRUE. Learning anything requires a certain amount of practice, drill, or even simple repetition. Hearing something twice in one day, and then writing it down, is far more likely to result in remembering it than hearing it once. See Chapter 1, "Study Tools" on pages 5-6 of the Text.

A 1-6) FALSE. To make studying from the textbook an active process, many students underline or "highlight" (with yellow marker) the paragraphs to which they wish to return when the time comes to review for an examination. This is probably the easiest way to keep notes while reading the Text (see page (3).)

A 1-7) TRUE. Every student, genius or average, learns by doing. Unless the student has already learned the course material (in which case he or she is probably in the wrong course), the Examples provide an effective, time-saving, and active learning experience. Some students may find themselves working the Examples faster than others. However, all will benefit from them for the reasons given on page 7 of the Text.

A 1-8) FALSE. The Performance Goals provide a quick check on your mastery of the course material. If you can already satisfy the Performance Goals of this course, in fact, you shouldn't be in it. If it takes you only 1/2 hour to satisfy the PG's for a chapter, you can go on to the next one. See page 6 of the Text, and pages (3)-(4) of this Guide; also see PG 1 A.

A 1-9) TRUE. The truth is that a good ability to transmit one's observations and ideas in written and spoken language is essential for success in science and engineering, as well as almost all other fields. We try to keep the