HOW TO STUDY CHEMISTRY

AN OVERALL STUDY STRATEGY

For an introductory science course such as Chemistry 1A, lectures usually provide the best guide to the study of the subject. The instructor presents and explains important material in lectures. Examinations are based primarily on lecture material. The text is often used only to more fully explain material covered in lectures and as a source for homework problems.

For these reasons, this study guide focuses on taking good lecture notes and suggests the following strategy. (1) Prepare yourself before each lecture by reading relevant portions of your text; (2) do your best to take complete, accurate, and organized notes; (3) review your notes as soon as possible after each lecture; and (4) use your text to clarify and complete your notes.

For maximum effectiveness, you should preread and review within twenty-four hours of the lecture. If you decide to use this strategy, you will find yourself studying regularly, reading and/or reviewing a little each night. Many surveys have shown that regular study produces best results—both in understanding and in grades.

You can also integrate homework, lab work, and additional in-depth reading into this regular cycle of prereading, notetaking, and review. In addition to the regular review of your lecture notes, you may find that a weekly or biweekly review will help you gain a clearer picture of the entire course and will help you prepare for quizzes and exams. Frequent review results in better retention than does a single, intensive review.

Whether you use the suggested strategy or decide to devise one of your own, you should keep in mind the advice given by previous chemistry students: don’t get behind; keep up with the reading assignments; don’t miss any lectures; do all assigned problems; use your TA (or someone else’s); get help quickly if you find yourself in trouble.

LECTURES AND NOTETAKING

A. Preread the assigned reading before class. At this point, don’t try to understand everything; just get a general idea of what the lecture will cover and become familiar with new terms. Look at chapter headings, subtitles, diagrams, captions, and scan the text briefly. This procedure does not take very long, but it will be of great help in following the lecture.

B. Come early to the lectures and leave late. Often instructors give helpful hints in the first and last minutes of their lecture—just when most people aren’t listening. Frequently they give an outline of the lecture, or they at least imply their organization in the beginning, for example: “Today we will get into ‘Metal Ions,’ but before we start with the topic we’ll talk a little about…” Your notes and, what’s more important, your understanding will be clearer if you are able to fit the pieces together by paying attention to such verbal outlines.

C. Take good notes. The harder you work during one hour of lecture, the less studying you will have to do at home. Your notes should be complete, though not to the point of looking like a transcript; little words, repetitions, and digressions can and should be eliminated. Some students feel that all they have to write down is the information on the blackboard; but what is on the board is frequently not sufficient for understanding. It is very important to listen carefully to the verbal elaborations and to take notes on them.

Following are some specific suggestions for note taking
• Write on one side of the page only, leaving the back of each sheet empty. Use the empty side to rewrite messy or unclear sections, to add information when studying the book at home, or to write down related material from the discussion group. This way you can create one convenient source for study and review.

• Use *abbreviations* to cut down on writing time. Apply symbols like ⇒ (leads to); ↑ (increase); ↓ (decrease) in regular sentences as well as in formulas.

• *Identify unclear areas.* If you miss part of a section or don’t understand what’s being presented in a part of the lecture, write down as much as you can catch, especially key words; skip several lines in your notes; make a big question mark in the margin of your notes. Later you will be aware that there is something you must clear up and complete.

• *Indicate experiments and demonstrations in your notes.* Watch carefully and listen for an explanation of the concept being exemplified.

• *Look and listen for relationships.* Each lecture will have a main topic (for example, “Metal Ions”) and about three to six subtopics. If these topics are stated by the professor in the form of an outline, very good; but if they are not stated directly, they are nevertheless implied, and you should try to discover them when studying your notes at home. Make it a habit to think about and write down a brief outline for each lecture, and you will gain a much better sense of how the whole course hangs together, how the details fit into the total framework, and what the relationships are between the different parts. This is also one of the best techniques to improve memory, because things are remembered better when they are seen in relationship.

• Look for categories of information. A student might have a list of facts in her notes without knowing what they belong to. This happens a lot when students just copy what is on the board. Example:

1. Methyl alcohol CH₃OH
2. Hardening fats, margarine, and so on.
3. NH₃—ammonia
4. Filling balloons

Without a categorizing label these facts are almost meaningless. In this case, the title would be: “Uses of Hydrogen.”

• *Add explanations and labels to diagrams, charts, and formulas.* Beware of simply copying what is on the board and spending too much time on the artwork. Diagrams and pictures can often be found in your text; so sketch them quickly and concentrate on the lecturer’s comments. Comments and labels will (1) provide connections to preceding and subsequent material and (2) provide more complete notes, which will facilitate review.

D. *Review your notes as soon as possible after class.* Many studies have shown that long-term memory increases dramatically if this is done. If you review your notes, even just briefly, on the day of the lecture, it will save you a great deal of study time. Some students have found it helpful to stay right in their seats after class and immediately go over their notes. Or, while walking to the next lecture, try repeating in your mind what you have just heard by asking yourself questions. What was covered today? What was it all supposed to mean? What were the topics? What did I not understand? That same night, study your notes carefully and use your text to clarify confusing points.

**READING THE TEXT**
A. *Read selectively.* Not all parts of the text should be studied with equal care. Reading assignments are often vague (for example, “Read chapters 9 and 10 this week”), and you must decide for yourself how to organize your reading. Here are three tools to guide you:

1. Use your lecture notes and assigned problems to determine reading priorities, that is, important points (topics extensively covered in lecture on which problems have been assigned), digressions (examples or special cases of important points), and background information (topics not emphasized in lecture).
2. Preread before studying a section in detail. Quickly scan the text to get an overview of the material and how it is organized. Look at the table of contents; titles and subtitles; diagrams, illustrations, and their captions; and introductions and summaries. Prereading is very effective in improving concentration, comprehension, and long-term memory.
3. Use problems to guide you to important material. Before reading your text, look at the example problems and the problems listed at the end of the section or chapter. Note the variables (for example, temperature, pressure, concentration, volume) which appear in the problems. Look for definitions and concepts involving these variables when reading the text.

B. *Read actively and ask questions.*

- Before reading a section or chapter, formulate questions by extracting questions implied in the problems and turning titles and headings into questions. Title: “Some Chemical Systems at Equilibrium.” A student’s questions: “What is a chemical system?” “What conditions define equilibrium?” “Why is ‘equilibrium’ important?” “Why is ‘equilibrium’ important?” Look for answers to your questions as you read.
- During the actual reading, continue to question. You needn’t question so much the detail as the organization and the importance of what you are reading. Ask: “Why was this section placed here?” or “Can I skip this section?” or “How does this new concept relate to previous concepts?”

C. *Find connections and relationships in the material.* In order to understand and better remember the overwhelming quantity of information contained in your notes and text, you will need to construct an organizing framework:

- Bring together all material on each topic. Create a single study source by integrating your lecture and lab notes with textbook material.
- Outline the reading assignment. Make a list of section titles. A pattern should emerge. This is especially important if the lecture and text follow different organizational schemes.
- Use introductions and summaries in your text and lab manual to gain an overview of a topic.
- Create your own summaries of the assigned reading. Try to condense each chapter into a single page of notes.

D. *Underline and mark the text with care.* Your goal in marketing should be to create a visual summary which will be meaningful when reviewing the text days or weeks later. Here are some general guidelines. (1) Read a paragraph or section before underlining. Then go back and mark selectively. (An effective form of instant review.) (2) Use your hi-liter sparingly; avoid indiscriminate underlining. Circle or underline summarizing sentences. (3) Write comments in the margin which will reorganize the text to meet your needs.

E. *Use the index.* The index can transform your text into a private instructor ready to answer your questions, clarify your notes, point out relationships. For example, a student might find in his lecture notes a complicated diagram, copied from the board without clarifying labels, and remember only that the instructor mentioned “hydrogen atom.” Looking in the index under this heading, he is referred to “H atom,” where he sees the following:

*H atom boundary conditions, 487 energy level diagram, 488 energy levels of, 472, 484, 487 line spectrum of, 469, 472 orbitals, 483, 487. He is not sure where to look next, but he does notice that most of the entries cluster around page 480. He turns to this page and begins to scan nearby pages. On page 488, he sees something resembling the diagram in his notes.*
Another index may organize the same topic differently:
Atomic structure
Bohr model, 470
Hydrogen atom, 476, 487
- Try looking under each word, for example, hydrogen and atom.
- If you cannot find your subject, think of a larger category that may include your subject as a subcategory.
- Notice the other entries under your subject. You may find additional information and begin to see relationships more clearly.

PROBLEM SOLVING
Chemistry is a problem-oriented course. In studying chemistry, you should keep in mind that your knowledge will eventually be used to solve problems. You may understand chemical concepts, definitions, formulas, and so on, but this knowledge will be of little value unless you can use it to solve problems. You should organize your studying accordingly:
- Study the example problems. Even though you may understand the concepts, working through an example problem will often disclose mathematical techniques, “tricks,” or shortcuts you need to know in order to apply your conceptual understanding.
- Do all assigned problems, even if they are not to be turned in. Many instructors give similar (sometimes-identical!) problems on exams.
- Practice problem solving. One of the best ways to prepare for an exam is to practice solving the kinds of problems you think will be covered. Look at assigned problems for clues. The more practice you have in problem solving, the less likely you are to make those obvious mistakes that cost valuable points.

A. Understanding the problem. Most problems, both on homework and exams, are “word” problems. You will almost never be asked just to solve an equation; instead you must sort through a lot of words to get the information needed to set up an equation. The most important step in solving any problem is to establish clearly WHAT IS WANTED. Here are some techniques helpful in sorting out the information given word problems:
1. Find out what is WANTED. Set it off clearly from everything else in the problem by circling, underlining, etc. Reread what you have marked, and don’t jump to conclusions because your problem is similar to another problem you remember. Take time to make sure you understand what you are to do. There are few things more frustrating than getting the right answer to the wrong problem.
2. Examine the data you have been GIVEN. Set off the important information by underlining or some other means (but use a different mark to distinguish the GIVEN from the WANTED). On long word problems especially, some students find it helpful to summarize both the GIVEN and the WANTED before starting to solve the problem.
   - Too little information. Some problems will omit “obvious” information (such as the value of the gas constant R or relevant thermodynamic data). You are expected either to know or to be able to look up such data. On tests many instructors will give you this information on the first sheet of the exam; in textbook problems such information is usually tabulated in the text or is given in an appendix at the back of the book.
   - Too much information. In multipart problems, you must select from all of the given data that which is needed to solve each part of the problem.

B. Doing it. Although you may clearly understand what is wanted and what is given, the connection between the two may not be clear. Here are some ways to clarify the connection:
- Draw a picture or a diagram.
• Summarize a chemical process by writing a reaction.
• Analyze definitions. Important relationships are sometimes hidden in definitions. For example, density is defined as the ratio of mass to volume. Pressure is defined as moles of solute per liter of solution.
• Look for similar example problems in the text.
• Set subgoals. Ask yourself, “What do I need to know to be able to solve the problem?” Set as your subgoal the task of finding any missing pieces of information.
• Use your imagination. Pretend you are looking into a very powerful microscope and can actually see atoms and molecules. How do they interact with one another?
• Reread the problem for word clues. Important information is often given in short phrases which are easily overlooked: “at constant pressure,” “for an ideal gas,” “for complete combustion,” “in an acidic solution.”
• Brainstorm. Write down everything you know about the kind of situation described in your problem. Assemble all your fragments of knowledge and see whether you can piece together a way to solve your problem.

C. Checking your answers.
• Is there a type of mistake you tend to make? Do you often make errors when working with scientific notation or when dividing fractions? Recheck these steps.
• Question your calculator. It will always give an answer, but only you can tell whether it is the right answer.
• Always ask yourself whether your answer makes sense: If you were asked to calculate the molecular weight of compound X, your calculated weight cannot be less than 1gm/mole. (no element or compound is lighter than hydrogen. If you were asked to calculate the pH of a 0.1 M aqueous solution of a weak acid using its dissociation constant, your calculated pH cannot be greater than 7. (The solution cannot be basic.)
• Use units to check your answer: Give 3 liters of 0.5 M NaOH, how many moles of NaOH do you have? Your answer should be in moles.

EXAMS
Some chemistry instructors prefer frequent short quizzes; others give only a midterm and a final. Quizzes require keeping up with course work because some instructors will announce a quiz only a few days before it is to be given, leaving you little time to prepare carefully planned selective review.
A. Preparing for an Exam.
1. Predicting the exam. Find out as much as you can about format and content of the impending exam. Ask fellow students, the TA, the professor, and try to obtain copies of old exams form the library or other sources.
   Preliminaries. When and where will the exam be given? (Exams are sometimes not given in the regular classroom.) What is the grading policy? (Is partial credit given? Will you be penalized for guessing?) Can you use your calculator? Should you bring a bluebook?
   Format: Will the exam contain problems requiring calculation, short-answer questions, multiple-choice questions, essay question? How many of each type? How will the points be distributed?
Content.
• Will the exam be cumulative (that is, will it cover all material to date), or will it cover only material introduced since the last exam? Will lab material be included?
• Listen carefully. Has the instructor raised questions and problems in recent lectures
• Without giving answers? Has s/he mentioned topics covered in earlier lectures?
• Has s/he suggested that the class “think about” certain concepts?
• Make a list of assigned readings. Include not only page numbers but also chapter titles and/or section headings. Note sections and chapters not to be covered by the exam.
• Make a list of assigned problems, noting what you were given and what you were asked to find.
• Look at your lecture note, your list of assigned problems. Which topics seem to have received the most emphasis? What kinds of questions have you been asked about these topics; what kinds of questions would you ask if you were trying to design an exam to cover these topics?

2. Scheduling your time. Make a long-range schedule. This should be done about three weeks prior to the exam. Note all commitments (deadlines for paper, exams in other classes, etc.) to get an overview of what you must do and how much time you can allot to each demand. Many students make such a schedule for the entire quarter. Make a detailed schedule. Some students set deadlines by which they will have covered a certain portion of the material. Others schedule study time each day and used the time flexibly. Some combine both methods. Choose whichever method seems to work for you. Reassess your progress every few days. Are you falling behind? Can you take time from other activities; can you make your review more selective? Beware of cutting down on sleep – this usually reduced efficiency.

3. Setting priorities. Apply this rule: If you can’t study everything, or if you must cram, concentrate on a few topics and review them thoroughly. Understand basic information first. The most difficult topics are not always the most important. In introductory courses, difficult material is sometimes presented to preview more advanced classes. You will often not be responsible for such material.

4. Taking a practice test. This is an important strategy suggested by many learning specialists to counteract test anxiety. You can “desensitize” yourself by simulating an actual test situation and applying your knowledge under realistic conditions.

The method:
• Make a list of problems and questions, using old exam questions, homework
• Problems and your own questions.
• Set a time limit, one that will force you to work at top efficiency.
• Work without interruption; try to finish your “exam.” Stop when time has expired.
• Evaluate your performance; give yourself a “grade.” Determine your strengths and weaknesses. Decide where you need more review.

B. Test-taking strategies.
1. Assessing the quiz or exam. Before starting to write, glance over the whole exam quickly, assessing questions as to their level of difficulty and point value. Get a sense of how much time to spend on each question. Begin to work on those questions with which you are most comfortable and/or those worth the most points. In general, in problem solving exams, as in essay exams, it is better to do the easiest questions first. In multiple-choice exams, on the other hand, it is probably better to work through from beginning to end (again, however, skipping very difficult questions). Never leave a question completely blank. Write down everything that seems to apply—you may receive partial credit.

2. Analyzing the question. Read each question carefully.
Underline or circle key words (see “Problem Solving”).
Jot comments and ideas in the margin as you think about the question. Ask yourself: What is this question asking? How is it related to what I’ve been studying? Have I seen a similar question? Clarify confusing questions. Add comments, clarifying remarks.

3. Writing down the answer. Show all work clearly. You may lose points for incomplete or messy answers. Write in pencil—not ink—so you can erase. If you write on the back of a page, make a note so that the reader will not overlook it.
Evaluate your answer. Does it make sense? See “Problem Solving” for techniques.
LABORATORY

Your lab work will account for about 30 percent of your total grade. In addition, many exams and quizzes will contain questions pertaining to laboratory material.

- **Be prepared.** You should read the current experiment twice before coming to lab. On the first reading, read the introduction and skim the text to get a general picture of the experiment (that is, procedures, amount of time required, objectives) and its relationship to previous experiments and/or the lecture. Look at the problems and questions for clues to procedures and concepts. Go through the procedure in detail during the second reading. Some students write outlines or draw detailed flow charts complete with pictures of test tubes, beakers, and so on, labeled with experimental conditions such as temperature, molarity, volume, weight.

- **Get help before you make a mistake.** Ask your TA about confusing points before you proceed. Rely on the advice of your TA rather than that of fellow students, who may also be confused.

- **Analyze your data as soon as possible after completing an experiment.** If you complete your lab work early, you may want to stay and analyze your data. This will give you a chance to confer with other students or your TA if you have difficulty with calculations or the interpretation of your data.

- **Notebook policy varies from TA to TA.** Listen carefully to your TA’s instructions. Ask questions if you are not sure about notebook policy. Here are some commonly followed notebook policies:
  - Use a bound notebook with numbered pages (not a spiral bound notebook).
  - Save the first few pages for a table of contents.
  - Record all observations and primary data (temperature, weights, volumes, the date, and so on) directly into your notebook.
  - Do not record data on scratch paper for later transfer to your notebook.
  - Do not remove pages from your notebook.
  - Draw a line through incorrect data; do not erase or obliterate.
  - Show all calculations; do not give just the answer.
  - Write answers to all questions and problems.

This material is abridged and adapted from Colin Watanabe and Friedel Gorden, How to Study Chemistry, rev.ed. (Berkley: Student Learning Center, University of California, 1977)