HOW TO STUDY CHEMISTRY EFFECTIVELY

Introduction

Every student would like an A in chemistry. Many students, however, first need to learn the techniques that will help them earn high grades. If you have been successful in high school without ever thinking about how to study, you might not be prepared for the fact that chemistry courses require a great deal of independent learning, and that you have to integrate material from lecture, textbooks, handouts, and problems. The techniques described here will help you study chemistry and other sciences more effectively. They will not only improve your grades but will give you more confidence as well, so that learning chemistry is a pleasure rather than a chore.

How to Read and Understand Your Textbook

Many students make the mistake of reading a textbook like a novel; they read and entire chapter once and then attempts to do the problems. It's not surprising that the problems appear too difficult and seem to belong to some other chapter. To learn the most from a textbook, you must *actively read*; that is, you must constantly be thinking about what you are reading, pausing to relate it to what you have just read before, and making sure you understand its applications. Ask yourself questions to make sure you are understanding the main ideas of the paragraphs; turn section headings into questions and then relate sections to each other and to the main topic of the reading assignment. Asking and answering questions helps you to not only concentrate on the main ideas but also increases your retention of the material. Your textbook provides you with learning objectives for each section; use those objectives to focus your attention on what you need to know. The process of self-testing is a skill that scientists at all levels use to learn new concepts. For the student, it is particularly helpful since it is also a form of exam preparation; answering questions on exams will be less anxiety producing when you have been answering questions all along.

To help yourself read actively, take notes in outline form on the text material. Your outline should include main ideas, important formulas, and their applications.

Survey chapters before you begin to actively read. That is, note the main headings and subheadings, read the introduction (previews in your text) to see how this chapter relates to previous chapters, read the lists of learning objectives, turn to the key terms and important formulas at the end of the chapter; these will all direct your attention to what you must learn from the text. Read each paragraph first, and then go back and outline or underline only the important material. Pay attention to the “Rule of Thumb” arrows on the side margin.

Review your notes after you finish, briefly going over main ideas and examples. Make an effort to understand and retain the material by engaging as many senses as possible as you actively read. Try to visualize many of the principles and examples described in the text. Remember chemistry describes the world in which you live, so that much of what you learn you can apply to familiar objects and situations.

Make sure you spend a significant portion of your study time doing problems. Your textbook provides you with many clearly worked-out examples followed by practice exercises. The only way you can be sure you really understand the problems is by doing them yourself. Even if you follow

the solutions in your text, this is no guarantee that you understand the problem well enough to do one like it on your own. By doing the practice exercises (HOMEWORK), you will not only ensure that you really understand the examples, but you will increase your chances of solving similar problems on an exam. People that play a musical instrument spend a lot more time practicing than actually performing. In any sport, players spend much more time in practice than in playing the game. In order to get good at anything you must practice!!! After completing a section, try to do the exercises assigned to you for that section. Keep in mind that chemistry is a problem-solving discipline, so that the more problems you solve, the better you will understand the material. As you read, make a note of other parts of the text that are not clear to you and also of the examples and exercises you are not sure of or can't do at all. Consult 1) lecture notes, 2) study guide, 3) instructors, and 4) classmates to clear up what you don't understand. Never let your questions go unanswered; if you do, you not only decrease your chances of doing well on exams, but you jeopardize your future understanding of chemistry since new topics very often depend on your understanding of past topics.

1. Survey the chapter.

2. Outline or underline as you read actively.

3. Do practice exercises and final exercises.

4. Keep a record of questions and any problems you don't full understand, so that you can consult instructors, classmates, textbooks, or lecture notes for answers.

Getting the Most Out of the Lecture

In listening as in reading, you must be actively involved to get the most out of it. If you actively listen to the lecture, your notes will be accurate and complete, and your time in the lecture room will be well spent.

Read the assigned material before you come to lecture. If you don't, much of your lecture time will be wasted. Without some idea of the topic being discussed, you will find it difficult to focus on the important ideas of the lecture. Your notes will be incomplete, and you won't be able to ask questions; the lecture will not help you to learn the material. On the other hand, if you arrive prepared, you will be able to determine and record the important information so that your notes will be useful for studying and for exam preparation.

Make sure you record all information written on the blackboard or overhead projector (except for tables and figures taken from your text). Try to take notes in an outline form that shows major topics, subtopics, and relationships between them. Pay close attention to the examples that were worked out in class and try to re-do them after class, perhaps changing values for practice.

Read over your notes as soon as possible, preferably the same day. Rewrite what is unclear. If you are uncertain about parts of what was said, compare your notes with those of other students or ask your instructor. Then go back and include that material in you notes. Think of your notes as a handwritten book and strive to make the accurate and complete.

1. Read the assignment before the lecture.

2. Try to take notes in outline form showing major topics, and their relationships. Include examples.

3. Read over notes the same day. Re-write, change, and add to notes where necessary.

4. Make sure your notes are complete. If you missed part of the lecture, find out what it was you omitted and fill it in.

Solving Problems

Most of your time in chemistry should be spent solving problems that are applications of concepts and formulas learned in lecture and from the text. You can improve your ability to solve problems by learning how to think about the examples that are solved for you in the text, study guide, and in the lecture, and also by learning how to think about the many relationships (formulas) used in the problem.

Understanding relationships and formulas is crucial to learning chemistry. Many students memorize relationships and formulas without taking the time and energy to think about them. This often leads to inappropriate applications and incorrectly solved problems. Ask yourself the following questions whenever you learn a new formula.

1. What system or change does this formula describe? What do the variables mean and what are their units?

2. When does it apply?

3. What are some examples of its application? What is its significance?

Formulas are listed for you in each chapter. Ask yourself these questions for all of these relationships. Make a set of "Important Formula" charts. If you actually think about relationships as you learn them, it will be easier to see how to apply them.

Note carefully which concept or relationships are used in the worked-out problems in the text, assignments, and class lecture. Why was this formula used and not one of the others in the chapter? What information given in the problem indicates that the problem should be solved in this way? You will find answers to these kinds of questions in the "Problem-Solving Hints" given in the textbook.

When you start to work on a problem, it is critical to first write down the information that is given (along with units) and to identify the unknown. Use a diagram whenever possible to show what is being described in the problem, and indicate the given and unknown values. Then try to plan out your solution before you start doing and calculations. If you aimlessly calculate values, you may generate superfluous data that may be confusing. To solve a problem, you must determine which relationships are relevant out of all those you have learned. Think of relationships that involve your unknown. Which ones include all or some of the given data? Be sure the relationships you use

apply to the system as described in the problem; for example, don't use formulas for gases in a problem about liquids. If you still can't see a method, think about relationships that involved the other values given in the problem. For example, if the volume and density of a solution are provided, then the mass is also known (d= m/V). If you now include the mass with known information, the solution may become apparent.

Think about the example problems you have studied. Solutions to previous problems may provide hints to solving new problems.

After you have planned the solution, then do the calculations. Use a calculator to save time and eliminate arithmetic errors. Be sure that the values you use have the appropriate units for the formula you are applying.

Check your answers for the following:

1. Make sure your answer is what the problem asked for.

2. Make sure your answer is reasonable. When you study example problems in your text and study guide, think about the magnitudes of the answers so that you will have some concept of reasonable answers. If you calculate that the mass of a molecule is 10kg, it is clear that you have made an error. However, if you calculate that 10^6 kJ/mol of heat are released by a reaction, you will not realize that you have made and error unless you have previously noted reasonable values for heat being released from chemical reactions.

3. Make sure your answer has the correct number of significant figures.

Problem-Solving Tips:

1. Identify the known quantities and the unknown quantities asked for.

2. Plan the solution: What do you know about the unknown that might link it to given information?

3. Perform calculations.

4. Check your answers.

Managing Your Time

Learn to manage your time. This skill will be invaluable, especially if you plan a career in science. Learning chemistry takes time and energy, and you should try to study some chemistry nearly every day. Devise a study schedule at the beginning of each week so that you will be studying chemistry throughout the week. Include periods for textbook reading before lecture, review of lecture notes, problem solving, and review for quizzes and exams. Make sure that your study schedule not only includes enough time to study chemistry, but also allocates sufficient time for other activities that you must complete during the course of the week.

Be specific in constructing your schedule; indicate which chapters or sections you plan to study, which set of problems to work out, and which topics to review for an approaching exam. Try not to schedule very long blocks of time for studying chemistry: 1- or 2-hour blocks of time interspersed with other work for different courses are best.

Devise your schedule at the beginning of each week by first looking at all of your assignments and then allowing enough time to complete them. Students tend to complete their assignments more often when they schedule chapter readings and problem solving at the beginning of the week and reviewing towards the end. Always allow yourself more time than you think you will actually need to complete the assignment. It is always better to overestimate the time you will need than to find out that you are short of time later.

It is critical that you follow your schedule and don't permit yourself to be distracted. If you carefully construct and follow your schedule and make necessary adjustments to accommodate each week's requirements, you should find that your free time may actually increase.

1. Construct a study schedule at the beginning of each week.

2. Be specific as to what you plan to do during your study sessions.

3. Overestimate the time you will need to complete each assignment.

4. Be sure to include in your schedule enough time to complete all other necessary tasks as well as time for leisure activities.

Tips on Creating a Study Area

To help your concentration, create a study space. Study in an area where lighting is adequate and distractions are few. Try to create an environment that is pleasant but without items that might divert your attention such as a radio, stereo, television, or telephone. Make sure that everything that you might need for studying is in your study area. This should include: paper, pens and pencils, calculator, computer, notes, outlines, and completed assignments as well as all textbooks and reference books that might be needed. Try to use your study area solely for the purpose of studying.

By creating a study space, you make your studying more efficient. You will reduce wasted time searching for needed material and minimize distractions, thus improving your concentration.

1. Study in a comfortable but efficient area minimizing distractions.

2. Make sure that your study area is equipped with all the items you will need for studying.

Using Study Groups

The effective use of study groups can be an important part of an overall study program that will lead to success in General Chemistry. However, many students have tried to use study groups, only to find that they were not helpful. Generally, study groups fail when students either do not know how to form an effective group or do not know what tasks a study group is best suited to perform.

Study groups should consist of three to six members who are serious chemistry students and committed to making the group meetings effective. It's generally a good idea to establish a consistent study time and place. Study groups are most effective for reviewing material that each student has previously studied on their own such as assigned chapters, problems, and old exams. If members do not individually prepare, the group meetings will not be helpful.

Each participant should be assigned a specific task to complete and present to the group. These tasks include solving specific problems, explaining sections of a chapter or of a lecture, preparing a chapter outline, etc. Each member should be responsible for covering different aspects of the material; the group will be assured of covering all the assignments. In addition, each member is accountable to the group as a whole, which has the effect of encouraging students to keep up with the course work.

Study groups acquire particular significance when preparing for a chemistry exam. While they are not a substitute for the review that should normally take place before an exam, they can be an important addition to that review process. Usually, it is a good idea to increase the amount of time a study group meets about 2 weeks prior to a major chemistry exam (usually from 2 to 4 hours a week). The additional time should be used for a general review of the material and for problem solving. Remember chemistry exams usually emphasize problem solving so that the group should spend most of its preparation seeking and understanding solutions to problems. Each member of the study group should prepare and explain to the group a section of the material that is to be covered on the exam and also to develop a set of problems and answers that encompasses the same material. Problems should be distributed to the rest of the group without the answers, and difficulty with certain problems can rely on the member of the group who developed the problem to explain the answer. This kind of studying for exams is extremely effective because it puts you, the student, in the role of the professor, deciding what information is important and likely to be covered on an exam and what is not. The process is also effective because it requires you to be actively involved in the learning of formulas and reviewing and what material you already know sufficiently.

1. Form a study group consisting of three to six serious chemistry students.

2. Try to convene at the same place and same time weekly.

3. Assign specific tasks to members.

4. Spend most of your time discussing and solving problems.

5. Increase the time for your sessions to prepare for exams. Each member should be responsible for preparing and presenting material that will appear on the upcoming test.

Preparing for and Taking Exams

To adequately prepare for an exam, you must first organize your time in advance. Start studying a few weeks before an exam by adding time to your usual study schedule, and use this additional time for exam preparation only. Survey the material that will be covered on the exam, and divide the relevant topics or chapters into categories based on your present level of understanding. For example, identify chapters that you know well, those that you have a limited mastery of, and finally

topics that you do not understand at all. Write out an approximate but detailed schedule including not only main chapters or topics you plan to cover during each week, but also specifically what you plan to study each day. Leave more time for the material you are unsure of as well as for the lengthier and complex topics, and spend most of your time solving problems. Because chemistry exams generally consist mostly of problem solving, your preparation can only be effective if you actually solve many relevant problems. Review the assigned problems, and solve additional problems in the text and study guide as well as from previous exams, if available.

Be careful not to review only the solutions of problems. Students who just review the solutions often find that they cannot solve problems on exams. The only way that you can be sure that you adequately understand any problem is by solving it yourself, writing out each step. For problems already solved, simply change given values and rework the problem finding a different answer. Remember, to be successful on a problem-solving exam, you must have the experience of solving many problems yourself.

Review your old exams to familiarize yourself with the kinds of questions you professor asks. Identify the questions you were most successful answering as well as those you could not correctly complete. Try to emphasize problems that resemble those that were particularly difficult for you in the past.

Try to work in a study group where you can solve problems and review lecture and textbook notes together. You will find it helpful to construct outlines of the work being covered; each member of your group can contribute outlines of specific topics as well as present solutions to the relevant problems. Remember, the more you write and think about the topics, the more you will retain and understand. Study group members can also develop new problems that the entire group can work on under simulated exam conditions. Such exercises will help to reveal your weak areas and develop test-taking skills.

1. Devise a schedule for preparation a few weeks before the exam.

2. Determine which topics you know well, which topics you do not understand completely, and what material you do not know at all.

3. Spend most of your time actually solving assigned problems, as well as new problems from your text, study guide, and previous exams.

4. Review previous exams to remind yourself of how your knowledge will be tested.

5. Work with your study group as much as possible developing outlines, solving problems, and creating practice exams.

The Night Before the Exam

The night before the exam should be used for a quick review of the more important topics or a review of the material you are still uncertain about. At this point, you should have studied all of the relevant topics and associated problems. Chemistry cannot be learned overnight and any attempts at cramming the work will only result in more anxiety during the exam. Learning any science is a

gradual process requiring much time and energy. Remember that your exam grades will reflect your study techniques. Adequate preparation not only increases your knowledge and improves the skills required for the exam, but also reduces your anxiety level so that you can think more clearly.

Taking the Exam

Read the directions carefully, and work first on the problems or questions you think you can answer correctly. Leave the problems you are very uncertain about for last. In this way, you will ensure that you receive credit for what you know and also you will elevate you confidence level to help you tackle those problems that you find challenging.

Try to show clearly each step you take in solving a problem so that you can check your work more efficiently and also so that your instructor can assign partial credit if that is his or her policy. After you solve a problem, make sure that you calculated the required quantity and that your value is reasonable. Make sure your calculator can perform all required operations, and replace your batteries before the exam.

1. Read instructions carefully.

2. Answer the questions or solve the problems you feel sure about.

3. Show all work clearly.

4. Use a calculator with all required functions.

5. Check your answers to see if they match the questions and if they are reasonable.

The Laboratory Period

Many chemistry courses have laboratory components. Students often do not consider the laboratory exercises important and consequently do not benefit from the experiments. However, laboratory exercises usually emphasize important concepts and also introduce laboratory skills that will be needed for more advanced courses. If you appropriately prepare, perform, and write up the laboratory experiments, you will benefit in the following ways:

1. You will develop a solid understanding of the concepts emphasized in the laboratory.

2. You will earn high grades for the lab component of your course.

3. You will learn lab techniques that you will need in future science courses and in scientific research.

4. You will acquire an understanding of the scientific method, which is necessary in order to understand scientific journal articles and to conduct research.

Preparing for the Laboratory Exercise. Make sure you understand the objective and procedures of the experiment before the lab. It is a good idea to outline the procedure so that you can spend

your time in lab actually learning and not blindly following the lab manual or trying to figure out what to do next. Your outline will also be helpful in writing up the lab later, if that is required. Also, by taking the time to understand the lab in advance, you are less likely to make mistakes and your data will be more accurate. Try to plan your time efficiently. If certain instruments require use by the entire class, try to use them early before the line form. TAKE NOTES IN THE PRELAB AND WATCH THE TEACHER VERY CAREFULLY AS HE DEMONSTRATES THE TECHNIQUES NEEDED FOR THE LAB!!

Prepare tables for data before the lab so that they can be neatly filled in. Students often jot down measurements during the experiment only to find later that they cannot identify these values. If you are uncertain about any part of the procedure or analysis of results, as the lab instructor before you begin. Do not take the chance of making a mistake and obtaining inaccurate data or a result, or even worse, injuring yourself or your classmates. Also, make sure you know how to handle all chemicals and equipment safely.

1. Read and understand the lab in advance.

2. Write up objectives and procedures of the lab as well as tables needed for data.

3. Ask your lab instructor questions before you begin.

4. Know how to safely handle all chemicals and equipment.

Performing the Laboratory Exercise. Familiarize yourself with the lab room. Know the locations of first-aid equipment, fire extinguishers, hoods, gas and water shut-off valves, reagents, equipment, and instruments. Know required general procedures such as the wearing of safety glasses (AT ALL TIME YOU ARE AT THE LAB STATION!!!) and storage of coats and books (ON YOUR DESK). Try to concentrate on your own work and if a problem develops, ask the lab instructor--not one of your classmates. Make sure you properly dispose of reagents, avoiding spilling harmful chemicals into sinks.

In most labs, you will work with a partner. It is a good idea to allocate tasks beforehand to avoid repetition and maximize your efficiency. Be sure that you both learn all lab skills, as they may be used in future lab sessions and may be tested in practical exams that are often given at the end of the course.

1. Become familiar with the lab room and general procedures.

2. If a problem or question arises during the experiment, do not hesitate to ask your lab instructor.

3. Clearly record all lab data. Do not use loose scraps of paper.

4. Appropriately handle all reagents, equipment, and instruments.

5. Follow all safety precautions and appropriately dispose of chemicals.

6. Share the lab work equally with your partner, and make sure you learn all the laboratory skills.

Writing the Lab Report. Try to write your lab report as soon as possible after you have completed the experiment. The lab will be fresh in your mind, and you will not need to waste time reviewing what the lab is about and what you actually did before you can write the paper. When writing the report, carefully follow the requirements given to you by your instructor (COURSE HANDOUT). If you are unsure about content, talk with your instructor and perhaps request a sample lab report (COURSE HANDOUT). If you work with a partner, your instructor requires individual reports. Make sure that your lab reports share only the lab data. WORK TOGETHER IN LAB, BUT DO YOUR OWN LAB WRITE-UP!!!!

Your report should be grammatically correct, well organized, and should contain all the information required. Lab instructors generally emphasize your data and analysis, but they also take into account the effectiveness of your writing technique.

1. Include only what is asked for by your instructor.

2. Write your own report.

3. Use tables and graphs to present data.

4. Review your returned lab reports, and determine how you may improve future reports.