**Suggestions for Studying General Chemistry**

One of the most common challenges that General Chemistry students have is that they don't realize the importance of being actively involved in their own learning. Many seem to think that coming to class and passively listening to the instructor's pearls of wisdom is all that is needed. No instructor, no matter how gifted they may be, can teach you anything if you aren't actively engaged in, and responsible for, your own learning. It is widely accepted among those who study learning that no idea can be transported wholesale from one mind to another. The hearer (or observer or reader) of an idea does not simply take the idea into his or her mind as a package deal. Each hearer hears a slightly different message, depending on their background and current ideas about the topic and the world. Each hearer responds a little differently and must do what is right for them to fit this new piece of information into their mind (unfortunately, sometimes filtering out parts, ignoring, or even distorting what they have heard) and re-construct their view of the world. Everyone is a little different; everyone has at least slightly different intellectual equipment and a different set of life and school experiences which they bring to the learning situation. Therefore, the learning experience is a little different for each person, even those in the same classroom.

The person who wishes to become a learner must be actively involved in constructing their own set of ideas. This process will be different in its details for each person, but each must go through a similar process of hearing (or seeing or reading) the new item, comparing it with what is already in his or her mind, and integrating the new information into the memory bank. This is not a simple process--it requires work! The work may take the form of reading and re-reading, thinking about the new information and how it fits in, practicing with the new fact or skill, making a few mistakes, allowing an "induction period" for the information to "settle in," talking about things with other students and/or the instructor, asking questions, etc., or (most likely) most (or all) of these in some combination which will be different for each student and each new item. How does this relate to learning General Chemistry? It is commonly (and correctly) perceived that this is a difficult course. There are a multitude of new words, facts, concepts, and techniques introduced in this course. (There are more new vocabulary words used in an introductory science course than in any other course except a foreign language.) Moreover, there are terms used which have one meaning in a general context (i.e., outside of Chemistry class), but another, much more specific one in the context of the course. You need to understand the word in the context of the course for full comprehension of the material. Beyond that, the new terms need to be used more precisely than in many other disciplines. And beyond that, you will often be required to use these concepts at a number of levels, including mathematical ones, simultaneously. Without an awareness of your own background (specifically including its limitations), a desire to work to learn, and some sort of effective learning strategy to guide you, the prospects for success are not good. What follows is an attempt to give you some suggestions which should help increase your chances for success in this course. (Many of these suggestions apply to virtually any course, but some are more specific to science and chemistry courses.) These suggestions are in no particular order. They do not comprise an exhaustive guide for study skills, nor will all of these comments apply to any individual. As soon as possible, read this over carefully and thoughtfully. Be honest with yourself. Ask yourself which of these apply to you. Which of these do you already do? At which could you use some improvement? Which had you not even thought about before? Refer back to this handout often during the semester for a "refresher course."

Take responsibility for your own learning

 Put in the required effort.

 Read the assignments carefully before coming to class, and then again after class.

 Do the assigned problems--and maybe extras for good measure.

 Come to class and lab prepared and on time. Class attendance is important even if your instructor doesn't specifically require it.

 Take complete notes in class and lab. Review these as soon after class as possible, fill in any gaps, and formulate questions which need answering. You may also want to make an outline of the major points of the chapter based on your notes and your reading of the text.

 In addition to the notes, be sure to write down all important announcements (test dates, due dates, assignments, changes to experiments, etc.)

 Pay attention in class. Listen to your instructor, not to the student next to you.
If anyone in the class or lab interferes with your learning (by talking or other distractions), then move away from them. If the problem persists, discuss the problem with your instructor.

 If you miss class, make sure that you get all the necessary information from the instructor or another responsible student. You are responsible for the material whether or not you are in class!

 If any problem arises, aggressively seek help as soon as you can to deal with it.

 Use all the resources (text, lab manual, instructor, tutor, exams on file, study skills center, library, other students, etc.) which may be available.

 Get questions answered as soon as you have them.

 Get timely feedback from whatever appropriate sources (study guide, instructor, other students, tutor center, exam reviews, etc.) you can. Remember that the results on exams, quizzes, and lab reports are feedback also. Use these as a guide to where you need additional work and practice.

 Believe what the instructor says--if he/she says something, assume that they mean it and act accordingly! If the new information doesn't agree with what you currently believe is true, then resolve the discrepancy.

 Follow directions carefully.

 Keep current in your studying--getting behind in a course where there are lots of new ideas, facts, concepts, etc. can be fatal to your understanding (and your grade!).

 Be aware of deadlines.

 Take a mature approach to the course--don't complain about the work, just do it! Remember that actions have consequences. If you don't like the (real or expected) consequences, change your actions! If your background is weak (as evidenced by difficulties with concepts or skills in problems in the early chapters, or from comments by your instructor like "I assume that you can already do X," and you know you can't do it), do what it takes to shore up the weaknesses as soon as you realize that this is necessary. Your instructor will have a set of expectations for your initial level of skills and knowledge--find out what that is and, if appropriate, do extra work early to bring your actual level up to his/her expectation level. Don't expect them to bring theirs down just for you! (It is not at all unreasonable for an instructor to expect you to remember something from your previous education or experience!) Progress towards your ultimate career and life goals is a cumulative process.

 Show (or develop) a willingness to leam--have a positive attitude about learning new things. Even if you have taken a very good High School course and have "seen this all before," you still have room to refine your knowledge and skills.

 Learn to take criticism in a positive manner. Nobody is perfect--we all have ways in which we can improve. Even if you don't like hearing the criticism, listen to it and gain something from it.

 Show your instructor the best you can do, not the least it takes to "get by."

Develop an effective set of study skills.

 Manage your time wisely--you should expect to spend at least 1-2 hours of study time for each hour in lecture, plus additional time to work on laboratory material.

 Pace your studying throughout the week and throughout the semester--"cramming" right before the exam is very unlikely to produce good results.

 Get enough rest and otherwise take care of your health.

 Find a place in which you can study effectively (noise level, light level, lack of distractions, etc.).

 Learn to read effectively (more on this below).

 Do many practice problems and get feedback to test how complete your understanding of the concept is.

 Learn when memorization is necessary and do it only when necessary. The list of things which must be memorized is fairly short (e.g., elemental symbols, nomenclature rules, solubility rules, definitions of units, rules for electrolyte behavior, etc.), but these things are crucial. Certain items cannot be derived from other knowledge and must be memorized--there is no other way to learn them. These are the things from which other bits of knowledge can be constructed and on which these will be based. However, don't waste time on memorizing lists of things which don't need to be memorized (either because they are not important or they will be available from tables, etc.). If you are not sure what does and does not need to be memorized, consult your instructor. Once you have memorized something, practice using it in appropriate situations.

 Look for patterns and generalities when you study.

 Form a study group with classmates and discuss words, concepts, problem-solving strategies, etc. to the benefit of all the members of the group. Having to explain something to someone else is an excellent way of finding out what you do and don't understand!

Learn to read effectively.

 This is one of the most important learning skills. "Reading" does not mean simply pronouncing words correctly in the order they appear on the page. It also means actively trying to get meaning from those words.

 As you read, think about the meaning of each word in the given context. Try to paraphrase the author's words to test your understanding of the new material and to help fit into your overall un-derstanding of the world and the subject.

 If you encounter an unfamiliar word, think especially hard about it. Can you figure out its meaning (from the context, or from breaking it down into prefix-root-suffix)? If not, consult a dictionary or glossary immediately! Expanding your vocabulary is a significant aid to learning.

 As you read a word, phrase, sentence, paragraph, section, or chapter, be always thinking of how this new information fits into what you already know. Does it extend it? Conflict with it? Does your previous thinking need revision based on this new information? Tying new information in with old is one of the most effective means of fostering long-term memory and understanding. Learning is a constant process of integrating new material into old, and revising how you view some part of the world.

 If you are having trouble understanding a concept, find another textbook and read the corresponding section to see if it is clearer to you there.

Develop your problem-solving skills.

 This will involve general thinking and reasoning skills as well as mathematical and symbolic reasoning and logic.

 Sharpen your basic mathematical skills so that they are second nature to you. One of the primary reasons students have trouble with General Chemistry is that their math skills are weaker than they realize--and then they compound the problem by not taking remediation steps when these are clearly needed. (The math needed for General Chemistry is not particularly advanced--algebraic manipulations, solving first-order and simple higher-order equations, graphing, exponential notation, and a few other skills. Most students have at least a basic knowledge of the concepts needed. What is commonly lacking, however, is a true facility with the manipulations and a gut-level meaning for the concepts and for numerical magnitudes.)

 Learn how to use your calculator effectively. If your calculator has lots of buttons whose purpose is unknown to you, this is of limited value.

 Learn and practice using units for physical quantities. These can be of immense help in setting up and checking mathematical procedures.

 Have a feeling for the magnitudes of answers and whether or not they are reasonable (i.e., are they "in the ballpark" based on previous experience?). Check every answer for mathematical and physical reasonableness.

 Learn to think your way logically through a problem.

 If your first approach to a solution doesn't work out, try another one. Be tenacious--don't just give up and look up the answer in the study guide. (Being able to follow what someone else did and being able to do it yourself are two very different things!)

 Try to figure out how the problem you're working on is like examples you've seen before and reason by analogy.

 Try to find more effective solutions for problems which arise repeatedly, so that you don't have to use "the long way" continually.

 Don't lose sight of what the question is asking. Re-read the question often as you are attempting its solution.

 If you need a piece of information, look it up using the index of your text or other suitable source.

 Don't be afraid to be wrong--as Sir Isaac Newton said many years ago, "Truth comes more easily out of error than out of confusion."

 Practice, practice, practice! If you are having trouble with the practice problems, then you are very likely to have trouble with the exam also!

Develop an effective test-taking strategy.

 This usually involves an initial scan of the entire exam to "get the feel" of the test, followed by a quick estimation of the time involved for each question or problem, then a decision of which questions to do in which order (this generally means answering the easier problems first as a "warm-up," followed by the more time-consuming ones), and finally, doing the questions themselves.

 If you run short of time, make a choice which will allow you to get the maximum amount of credit in the given time. Set problems up, even if you can't finish the solution.

 If you have extra time, make use of it by reviewing your work and checking your answers for mathematical and physical reasonableness.

 Stay calm and pace your work to give yourself the best shot to show what you can do.

Try to get "the big picture."

 Try to integrate what you are currently being exposed to into what you already know (or you think you know!). Do your previously-formed ideas fit this new situation? Do they need modification--or even need to be discarded and reformulated?

 Try to integrate new material with the old, integrate material from different courses and/or disciplines, integrate material between lecture and lab.

 Look for as many patterns and generalities as you can.

 Learn to "chunk" material into "packages" of related concepts to aid memory and use.

If the above seems like a lot to do and remember, why are you surprised? Did anyone ever tell you that it would be easy? To paraphrase the opening line of F. Scott Peck's The Road Less Traveled, "Learning is hard!" If you believe that there is some magic formula for effective learning that makes it easy, please tell me about it! I am not aware of any! (If you really do believe this, however, I suspect that you have been deceived in this regard.) Putting in the requisite effort in the appropriate way will bring success. (Unfortunately, knowing as you are progressing through the semester what is "the appropriate way" is not always easy!) As was stated earlier, no instructor can do the job for you--but all instructors can help you on your journey to learning. If you do the right sort of work, then they will be more than glad to do their job--that of helping you learn in an effective fashion. What you learn (both facts and attitudes) in your college years is a big factor in determining how well you will do for the rest of your life. The more effort you put forth now, the more likely you will enjoy what you do in the future.

**SYNTHESIS STRATEGIES FOR ORGANIC CHEMISTRY**

1. Know how to prepare a functional group and what can be made from a functional group. For example, know how to prepare alkenes and what can be made from an alkene. The best way to memorize these reactions is to make flashcards. Include stereospecificity of reaction, where needed. This is most likely the most important tool you need to do synthesis problems. If you don't have these "basics" down, your success will be minimal.

2. If you don't see how to begin the synthesis, work backwards from the final product. Use the logic from step 1, above. Ask yourself, how would I prepare the final product in one step? (How do you prepare a functional group?)

3. Look for whether the number of carbons in the product has stayed the same or increased/decreased. For increasing carbons, consider Grignard reactions, coupling reactions, etc. For decreasing the number of carbons, decarboxylations, ozonolysis are common.

4. Alkenes and alcohols are good intermediates. With alkenes, many addition reactions are possible. Also, orientation of the additions (Markovnikov or Anti-markovnikov) gives you flexibility in designing a synthesis. With alcohols, substitutions and oxidation reactions are plentiful.

For instance, addition of H2O/H+ across the double bond in 1-butene (Markovnikov addtion) would yield 2-butanol, which could be oxidized to butanone:



On the other hand, addition of B2H6 with H2O2 (Anti-Markovonikov addition) would result in 1-butanol, which could be oxidized to butanal:



5. With aromatic compounds, look at the orientation of substituents on the ring (ortho, meta, para) of the products, to help you decide in which order to add reagents. Know which substituents are ortho/para directors and which are meta directors. If the atom directly attached to the ring has one or more lone pairs, it will be an ortho/para director. Alkyl groups are also ortho/para directors. If the atom directly attached to the ring has a pi system (multiple bond) or a formal positive charge, it will be a meta director.



In the above case, you would oxidize the methyl group to the carboxylic acid first, using KMnO4. Now that you have a meta director, nitrate the ring using HNO3 with H2SO4 as a catalyst.



In the above reaction, you must nitrate the ring first, since a methyl group is an ortho/para director. After nitration, oxidize the methyl group to a carboxylic acid. Notice that oxidation, followed by nitration versus nitration followed by oxidation gave very different products.

6. You must practice doing synthesis problems -- it's not a "spectator sport". As with any skill, the more you practice, the more proficient you become at that skill.

**STRATEGIES FOR IDENTIFYING AN UNKNOWN ORGANIC COMPOUND**

1. Gather the following information: boiling point (if a liquid unknown), melting point (if a solid unknown), IR spectrum, mass spectrum, PMR spectrum, decoupled CMR spectrum (optional).

2. When analyzing the IR spectrum, remember that the absence of a band is just as informative as the presence of a band. For example, if OH band is absent, you can eliminate the possibility of an alcohol or carboxylic acid functional group.

3. For a given functional group, more than one band is used to identify that functional group, and they all have to be present. For example, to identify an alcohol, both the OH and the C-O bands must be present.

4. Using the mass spectrum, identify the presence or absence of Cl or Br in the compound, based on isotopic abundances of these halogens. Try to use the molecular ion peaks, not the base peak, to look for a 3:1 abundance of the M:M+2 peaks (Cl present) or 1:1 abundance of the M:M+2 peaks (Br present). The molecular ion peak is the signal of highest mass which is also of appreciable abundance, and gives the molecular weight of the compound. While some mass spectra will not show a molecular ion peak, the majority of the spectra will have this peak and it is reasonably obvious. Alcohols and aldehydes often will have a M-1 peak or an M-18 peak instead of a molecular ion peak. Also, if the molecular weight is an odd number (not even), then nitrogen is probably found in the compound.

4. Using the boiling point or melting point and the functional group of highest priority, set up a list of possible compounds from the CRC Handbook of Tables for Organic Compound Identification, or your organic lab text. Consider compounds in the range of ±10 of the measured boiling point or melting point.

5. Start narrowing down this list based on molecular weight and presence or absence of other functional groups.

6. Use the NMR and CMR to eliminate any further possibilities. Remember that the decoupled CMR will tell you how many carbon environments are present in the compound.