Introduction

I.1 What is Chem 100 All About?

Welcome to Chem 100, the preparatory chemistry class at CSUN. This class is designed to help you develop skills that will be essential for your success in subsequent chemistry courses. These skills include reading about science with comprehension, developing good study habits, solving scientific problems and doing basic math operations. You will also learn some fundamental physics and chemistry principles like how to apply the scientific method, details about the structure of matter, chemical reactions and chemical nomenclature, and how to do fundamental calculations involving scientific units. In addition, you will learn how to predict the products of chemical reactions and be able to anticipate the properties of substances you have never seen, and you will amaze your friends and family by being able to count invisible objects! All of these skills that you will acquire are certainly worth the effort you will expend to master them.

In addition to helping you develop essential science skills and learn important chemistry concepts, this class also serves another very important purpose. In this class you will learn how science works, how important chemistry is in everyday life and how science offers us the potential to solve many of the most pressing problems facing society today. An appreciation of science is something that is not widespread among the adult general public in the United States. This is unfortunate. Dr. Jon Miller, political science professor at Michigan State University and the author of a widely cited survey on science literacy, has estimated that only 28% of the American population are scientifically literate. This means that only 28% of our citizens can follow complex science issues such as stem cell research, global warming or the control of viral infections, and render an informed opinion on them. This is just slightly better

than adults in Europe and Japan.[1] Although this number is rather low, there has been a steady increase in scientific literacy among adults in the United States during the last 20 years despite the fact that U.S. high school students continue to perform more poorly than most European students on achievement tests. One reason cited for this increase is that the United States is the only major nation in the world that requires its college students to take general science courses.[2] Miller suggests that, unlike high school science classes, college science courses come with high expectations. In this preparatory chemistry class you will be asked to think critically about scientific issues. You will focus on how to understand and evaluate the subject matter rather than simply "knowing" the course content. Hopefully this experience will be a major step toward developing your scientific literacy.

As you become a thoughtful and informed citizen in a complex world, your scientific literacy is important. It has been shown that individuals tend to ignore complex issues if they are not able to understand them.[2] A knowledge and understanding of science enables you to participate in discussions of scientific issues and to make thoughtful decisions that affect you personally or that impact society as a whole.

I.2 Chemistry in Perspective

For many of you this class may be your first introduction to the field of chemistry. While the majority of students in this class are not chemistry majors, the fact that this is a course needed for your major suggests that chemistry is an area of science that overlaps with your major. In fact, an understanding of chemistry is important for many other disciplines and numerous careers in science. Many of these connections are noted in

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[1]Michigan State University (2007, February 27). Scientific Literacy: How Do Americans Stack Up?. ScienceDaily. Retrieved July 14, 2010, from http://www.sciencedaily.com-/releases/2007/02/070218134322.htm

[2]Retrieved July 14, 2010, from http://www.sciencenews.org/view/generic/id/56517/title/Science_literacy_U.S._college_courses_really_count.

Figure I.1. Because of these widespread connections, chemistry is often referred to as the *central science*. Modern studies in traditionally separate disciplines such as biology and physics have become so closely intertwined with chemistry that the boundaries that once existed are no longer recognized.

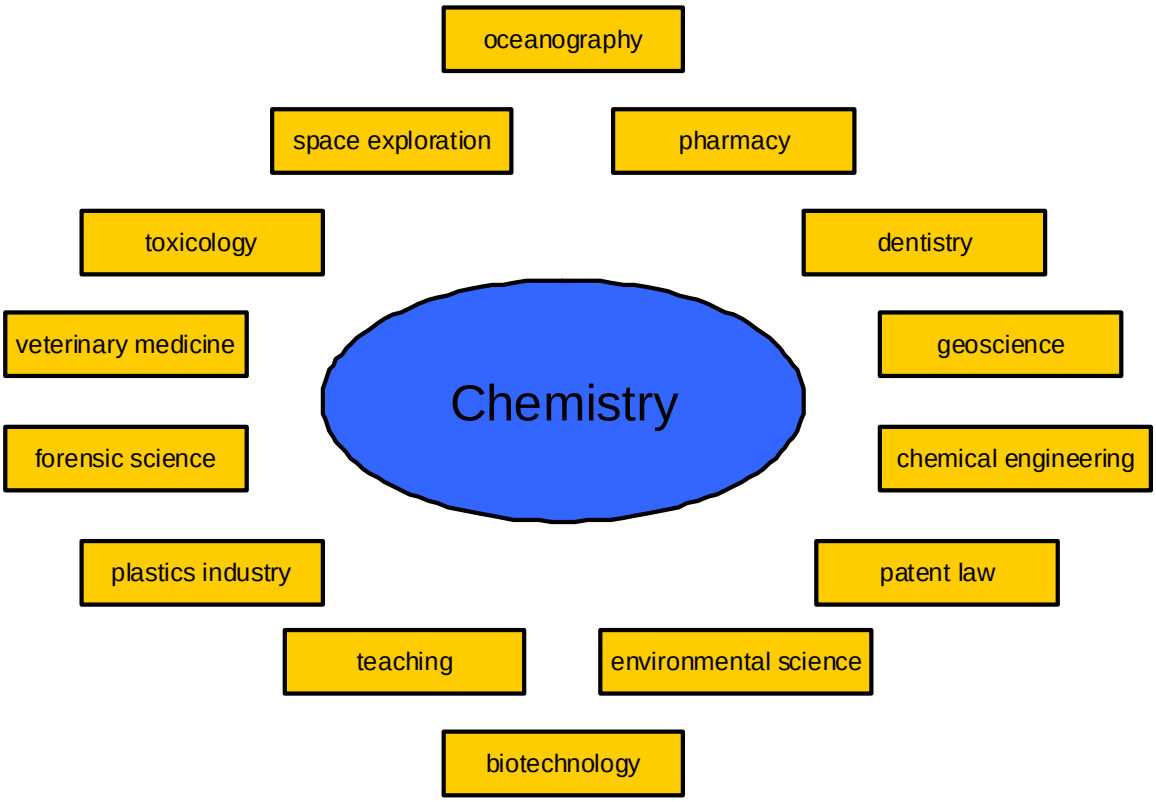

Figure I.1 Career options related to chemistry (partial list)

One of the goals of chemistry is to understand what materials are made of and to use this information to explain the properties of substances. This knowledge enables chemists to design new materials with specific and desirable properties; for example, drugs, plastics, computer screens, paints, adhesives and clothing. Because chemistry attempts to understand the world around us, it attracts individuals with a strong streak of curiosity. In fact, the field of chemistry developed from the musings that such curiosity

engendered. Individuals wondered what matter was composed of and why certain substances had particular properties. A timeline indicating some milestones in the development of chemistry is shown in Table I.1.

Table I.1 Early Milestones in the Development of Chemistry

Date	Event
430 BC	Democritus of ancient Greece proposes that all matter is composed of small indestructible units called atoms.
300 BC	Aristotle of ancient Greece proposes that four elements - fire, air, water and earth - make up all matter.
300 BC - 1600s AD	During the Age of Alchemy alchemists attempt to convert cheap metals like lead into gold.
1661	Robert Boyle publishes *The Sceptical Chymist* in which he refutes the four-element view and advocates rigorous experimentation to study the composition of matter.
1764 - 1794	The French scientist Antoine Lavoisier proposes the law of conservation of mass and pioneers quantitative chemical experiments.
1783	The French physicist Charles-Augustin de Coulomb describes the electrostatic force between electric charges.
1808	English chemist John Dalton publishes the first modern atomic theory of matter.
1869	Russian chemist Dmitri Ivanovich Mendeleev publishes a periodic table of the elements.
1897	British physicist J. J. Thomson discovers the electron.
1911	Physicist and chemist Ernest Rutherford develops the nuclear model of the atom.
1913	Danish physicist Niels Bohr develops the first quantum mechanical model of atomic structure.

There have been many other important advances, especially in the last hundred years, that are not listed in Table I.1, however, it is important to note two aspects of this historical record. First, the detailed theory about atomic structure is relatively new. In

the last 125 years scientists have discovered subatomic particles like the electron and the proton and proposed a comprehensive model of the atom. Second, the accomplishments highlighted in Table I.1 were often the outcome of experiments done with relatively primitive instruments. Experiments such as those carried out in Rutherford's laboratory in the early 1900s were done using tools much less sophisticated than those used in a general chemistry laboratory. It is important to note that they were done very carefully and it took incredible insight to interpret the results fully. Rutherford was a revolutionary thinker when he proposed the nuclear model of the atom.

I.3 Why Do Chemistry Classes Seem So Difficult?

For most students a chemistry class is a new experience and they have heard that chemistry classes are some of the most challenging that they will take. This is very true, but perhaps not for the reasons most people think. First, the language of chemistry is different and precise. Even familiar words may have a special meaning in a chemistry class. Also, in order to be successful in a college chemistry class you must practice a wide range of skills, including mathematical and analytical skills. However, perhaps the most important reason a chemistry class seems so challenging is that it demands a significant time commitment! It takes time to digest the new concepts you will be exposed to and even more time to develop a firm understanding of how to apply these ideas by regular practice doing problems both in class and as homework. Think about successful athletes and accomplished musicians. They do not develop proficiency without practicing their most basic skills every day! Success in chemistry is no different. Perhaps in high school you found that memorization of the subject matter would serve to get you a high grade. This approach might have provided you with a *working knowledge* of the subject. In a college chemistry course the expectation is that you will develop a deeper understanding of the subject matter. This cannot be achieved by memorization or by spending many hours each week in inattentive or multitasking type studying. How you spend your time studying is actually more important than how much time you spend.

In order to develop the problem-solving skills that will be needed for success in a chemistry class, please consider the following.

- Be prepared to take an active part in classroom discussions. Do a quick read of each assignment in the text before it is discussed in class. This allows you to think about the material and identify areas that you have questions about. Your questions should be written down and asked at the earliest opportunity.

- Take careful notes in class. It is not just important to take notes on the information written on the board. After class, summarize all class discussions in your notes. Try to record examples and stories that will help you "recreate" the class session when you study later. Ask questions about any sections you have difficulty reconstructing. Your notes will be your most important reference when preparing for exams and quizzes, so strive to make it as complete and organized as possible.

- Ask questions in class and make note of anything that is not clear so you can also ask questions later. Most students are reluctant to ask what they fear is a "dumb question". There is no such thing as a dumb question. You can bet that if you have a question many of your classmates have very similar questions about the material. This kind of dialogue between students and instructor is what makes classroom time so valuable, so take full advantage of this opportunity.

- Reread the text assignment after the lecture. Look carefully at the problems worked out in the text and then try all of the practice problems. Keep a list of questions that you have about any items that are not clear and be sure to get answers to them as soon as you can. One of the best ways to keep track of your questions is to e-mail your instructor as questions arise.

- When you have finished a reading assignment, test your skills by doing the homework as if you were taking an exam; that is, do not use notes or example

solutions to assist you. If you can't answer a question, ask your instructor or a knowledgeable classmate for assistance in setting up the solution. The exact answer is much less important than knowing how to map out the solution. When you are able to do this it means that you are developing an understanding and an ability to tackle problems with slightly different slants on the same topic. For areas where you are having trouble with the homework, practice by doing similar, unassigned problems. It is really important to approach new problems and not just redo and memorize solutions to the assigned problems. You will always see new problems on a chemistry exam!

This approach takes time. You must be fully committed to this level of work in order to succeed in this class.

I.4 The Course Text

Finally, a few comments are in order about the textbook prepared by CSUN faculty for this course. Most commercial textbooks attempt to appeal to a broad audience. In order to "cover all bases", such books contain much more material than is generally covered in any given course. The text you will use was prepared specifically for Chem 100 at CSUN. It addresses the fundamental topics that the CSUN chemistry faculty find are essential for success in subsequent chemistry courses. Consequently, there is no "extra material" presented in this text. You will be asked to demonstrate mastery of all of the core concepts presented in this text in order to advance to the general chemistry course sequence.

Each chapter begins with a list of student *Learning Objectives*. These are your goals as you work through the chapter, and are important indicators of whether you have mastered the material. Refer to the *Learning Objectives* often. Try your best to achieve each objective listed for the chapter. If you are not able to meet an objective, seek assistance.

The body of the text is written in a rather conversational style. Worked *Examples* are provided to illustrate all of the important concepts. These are regularly followed by *Check for Understanding* questions where you are asked to demonstrate an understanding of a particular concept. The complete solutions for all *Check for Understanding* questions are found in Appendix B.

Throughout the body of the text keywords are **bolded** and listed in order of presentation at the end of each chapter. A *Glossary* of these terms is found in the back of the text. Chemistry, like all disciplines, has its very own vocabulary. It is absolutely essential that you learn the keywords that make up this language. It is especially important that you remember not only the **meaning** of each bolded term, but any **symbol** used in connection with it. In addition to knowing what a boldface term means, you will need to be able to apply this information to problem solving.

At the end of each chapter you will find a modest number of *Exercises*. You should do all of these problems as homework. Generally these will not be turned in or graded; however, your instructor will require that your solution to particular problems be submitted for grading and credit. The answers (but not the solutions) to selected questions are found in Appendix C. These exercises serve as a very important test of your mastery of the core concepts presented.

In order to keep the cost of the text to a minimum, it is available to you in the form of an e-book that you can print in its entirety. This e-text has hyperlinks throughout that are designated in small, bold, red font (**this is how a hyperlink will look**). Clicking on these links will take you to helpful sections of the text, or to external resources that provide additional examples, practice problems or other material to assist you.

Chemists derive considerable delight from unraveling the explanations of how and why materials in the physical world behave as they do. As you start to explore this area of science, hopefully you will develop a sense of this excitement and be encouraged to learn more about this exciting field. Good luck in your endeavors.