Chapter 1

I Passed Chem I, But What About Chem II?

In This Chapter

- Comprehending chemistry
- Discovering science and technology
- Examining the general areas of chemistry

You already know what chemistry is. You passed your first year of high school or your first semester of college chemistry. Now you're ready to take on your second year or second semester, and you want a resource to help you explain concepts in plain English. This chapter sets the stage for the rest of the book by showing you what the differences are between Chem I and Chem II so that you can relate better to this new material. It also relates some of the major areas of chemistry to the topics you'll be studying in Chemistry II. If you're already in the midst of a Chem II college or high school course, you may want to skim over this chapter for a quick review of some basic concepts and then go right to the subject area in the book that is troubling you.

If you bought this book just to have fun discovering something new and aren't taking a chemistry course, you may need a little refresher on the really fundamental chemical topics. I suggest buying a copy of the first book in this series, *Chemistry For Dummies*. That book, now in its second edition, can give you the basics and make this book more meaningful.

Teaching chemistry is very enjoyable. For me, it's more than just a collection of facts and a body of knowledge. Although I wasn't a chemistry major when I entered college, I quickly became hooked when I took my first chemistry course. The subject seemed so interesting and so logical. Watching chemical changes take place, figuring out unknowns, using instruments, extending my senses, and making predictions to figure out why they were right and wrong all seems so fascinating. Your journey into Chem II starts here.

Grasping the Nature of Chemistry II

Chem I, in most schools, is a mixture of a lot of different topics. You naturally find some carryover between topics; you finish the chapter on gases and only briefly cover those topics again, until you hit the final exam. Your Chemistry II class is more consistent in these topics. Chem II is also much more mathematical than Chem I, which was great for me because I always enjoyed the quantitative aspects of chemistry more than the descriptive part. That's why I am an analytical chemist instead of an organic chemist. I enjoy working with numbers.

The following sections give you a quick reminder at the content in a typical Chem I course and then show you what to expect in a typical Chem II class that you are or might be taking.

Recapping general Chemistry I

In your first couple of weeks in your Chemistry II class, you probably will review the basics of what you covered in your Chemistry I class. I dedicate the chapters in Part I of *Chemistry II For Dummies* to these topics to help you review these important topics. Here are the topics you can find:

- **Problem solving:** The metric or SI system is essential to studying chemistry at any level. You need to be able to use the factor-label method of problem solving, also called *unit analysis.* This method allows you to manipulate units to generate the set-up for a particular problem. About this same time you become proficient in determining the number of significant figures you should report in your final answer. Refer to Chapter 2 for more information.
- **Atomic structure:** Having a firm understanding of subatomic particles (protons, electrons, and neutrons), the nucleus, and the electron clouds is important when taking a chemistry course. Chapter 3 gives you an overview of these topics. You can also find information on *electron configurations* (the way to represent the various electrons in an atom), average atomic masses, and the mole concept. For an overview of these topics, see Chapters 3 and 4.
- **The Periodic Table and periodic properties:** Chemistry I gave you the basics on electron configurations, ionization energies, sizes of atoms, and a host of other topics related to the periodic table. You definitely need this knowledge when studying Chem II. Chapter 3 gives you a brief overview.
- **Bonding:** Chemical bonding, both ionic and covalent, form an important part of Chem I. Having a firm foundation on these topics is also important in Chem II. See Chapter 3 for a review.
- **Molecules, compounds, and chemical equations:** Here is where chemical nomenclature was first introduced in your Chem I class. You may remember discussing chemical formulas, chemical names, and vice versa. Calculating molar masses and determining the empirical formula

from percentage data is also important. You also figured out how to balance chemical equations. Chemical nomenclature is an absolute necessity of Chemistry II as well as the balancing of chemical equations and the determination of molar masses. For a review, refer to Chapter 4.

- **Reaction stoichiometry:** You probably remember that this topic was a main crux of your Chem I course. You learned how to calculate how much — how much reactant, how much produce, how many moles, how many grams, and how many particles. Balanced chemical equations go hand in hand to allow you to do these calculations. You also focused on the basic reaction types and sometimes even a little solution stoichiometry. The reaction stoichiometry and the mole concept are of primary importance in Chem II. Flip to Chapter 4 to ensure you have a good understanding of these topics.
- **Solutions:** More than likely you studied solution concentration units, especially molarity and molality, in your Chem I class. Solution concentrations are extremely important in Chem II. Refer to Chapter 5 for a review.
- **Gas properties:** Many textbooks and Chem I instructors cover the properties of gases, including numerous gas laws and the kinetic molecular theory. Understanding the kinetic molecular theory also makes it easier to see how the various factors affect the kinetics of a reaction in Chem II. Check out Chapter 6 for more info.
- **Nuclear chemistry:** Some instructors cover nuclear chemistry as part of the Chem I curriculum; some cover it in Chem II. Chapter 17 touches on what you need to know.

If you want more in-depth explanation of these topics, you can check out my book, *Chemistry For Dummies,* 2nd Edition (John Wiley & Sons, Inc.).

Looking to where you are now: General Chemistry II

In Chem II you can expect to encounter the following topics, but not necessarily in this exact order:

- **Chemical kinetics:** A Chemistry II class usually covers this topic early after you finish reviewing the topics of Chem I. *Kinetics* is the study of the speed of reactions. Along with kinetics reaction mechanisms, the series of steps a reaction proceeds through in going from reactants to products is included. Chapter 7 covers kinetics.
- **Chemical equilibrium:** This is the largest topic in most Chem II classes. An e*quilibrium* is established when a chemical reaction goes from reactants to products and at the same time is also proceeding from products to reacts. These two reactions occur at the same reaction rate (speed). You can uncover all the different types of equilibriums: homogeneous,

heterogeneous, acid-base, solubility, and complex-ion. You can also find out about ways to manipulate the equilibrium system so as to form as much product as possible. I discuss equilibrium in Chapters 8, 9, and 10.

- **Thermodynamics:** Thermodynamics is another important topic of Chemistry II. *Thermodynamics* is basically the study of energy transfer. It builds on the thermochemistry concepts of Chem I, but it has the goal of being able to predict under what conditions a reaction is spontaneous. Chapter 11 covers thermodynamics.
- **Electrochemistry:** The study of batteries and cells also appears in Chem II. You figure out how to balance redox reaction and then move on to electrochemical cells. You discover all about cells and batteries, including automobile batteries and flashlight cells. Chapter 12 explains electrochemistry in more depth.
- **Radioactivity:** Chemistry II classes sometimes cover this topic. Sometimes Chemistry I classes cover it. *Radioactivity* essentially is the spontaneous decay of an unstable nucleus to a more stable one. This is the stuff of atomic bombs and nuclear power plants. Chapter 17 discusses radioactive decay, half-lives, fission, and fusion.
- **Other topics:** Some instructors also cover organic chemistry and biochemistry. I cover these topics in Chapters 13 through 15.

Examining the Branches of Chemistry

As you go through your Chemisty II course, you may actually start to wonder what chemists do all day. Well, some make things (synthesis), others examine the properties of things (analysis), and others explain things (teach). But all chemists have a specialty area in which they have received more training. The following describes the general areas of chemistry.

- **Physical chemistry:** This branch figures out how and why a chemical system behaves as it does. Physical chemists study the physical properties and behavior of matter and try to develop models and theories that describe this behavior. Especially keep this branch in mind when you're studying thermodynamics in Chapter 11.

- **Analytical chemistry:** This branch is highly involved in the determination of the properties of a substance (analysis). Chemists from this field of chemistry may be trying to find out what substances are in a mixture *(qualitative analysis)* or how much of a particular substance is present *(quantitative analysis)* in something. Analytical chemists typically work in industry in product development or quality control. If a chemical manufacturing process goes wrong and is costing that industry hundreds of thousands of dollars an hour, that quality control chemist is under a lot of pressure to fix it and fix it fast. A lot of instrumentation is used in analytical chemistry. Chapter 12, electrochemistry, is a typical topic studied by analytical chemists.

- **Inorganic chemistry:** This branch is involved in the study of inorganic compounds such as salts. It includes the study of the structure and properties of these compounds. It also commonly involves the study of the individual elements of the compounds. Inorganic chemists probably say that this field is the study of everything except carbon, which they leave to the organic chemists. Inorganic chemists are interested in the descriptive chemistry of the elements.
- **Organic chemistry:** This field is the study of carbon and its compounds. It's probably the most organized of the areas of chemistry — with good reason. There are millions of organic compounds, with thousands more discovered or created each year. Industries such as the polymer industry, the petrochemical industry, and the pharmaceutical industry depend on organic chemists. Chapters 13 and 14 describe aspects of organic chemistry. Much more about organic chemistry can be found in *Organic Chemistry II For Dummies* (John Wiley & Sons, Inc.).
- **Biochemistry:** This branch specializes in living organisms and systems. Biochemists study the chemical reactions that occur at the *molecular level* of an organism — the level where items are so small that people can't directly see them. Biochemists study processes such as digestion, metabolism, reproduction, respiration, and so on. Sometimes, distinguishing between a biochemist and a molecular biologist is difficult because they both study living systems at a microscopic level. However, a biochemist really concentrates more on the reactions that are occurring. Check out Chapter 15 for a taste of biochemistry, but for a full meal see my book *Biochemistry For Dummies* (John Wiley & Sons, Inc.).
- **Biotechnology:** This is a relatively new area of science that is commonly placed with chemistry. It's the application of biochemistry and biology when creating or modifying genetic material or organisms for specific purposes. It's used in such areas as cloning and the creation of disease-resistant crops, and it has the potential for eliminating genetic diseases in the future. I also suggest you check out my book *Biochemistry For Dummies* (John Wiley & Sons, Inc.) for more information.

Comparing Macroscopic versus Microscopic Viewpoints

As you go through your chemistry course, pay attention to the way your instructor shifts from talking about matter in terms of atoms and molecules and then shifts very naturally into the concrete world of grams and kilograms. These two viewpoints are called the *microscopic* viewpoint and the *macroscopic* viewpoint. Nearly all chemists, no matter what field they study, study the world around them in two ways:

- **Macroscopic view:** This view is what you see, feel, and touch. This is the world of dirty lab coats — of mixing solutions and weighing out elements. This viewpoint is the world of experiments, or what some nonscientists call the real world.
- **Microscopic view:** This view focuses on work with models and theories. Chemists may describe a chemical reaction, such as the Haber reaction to produce ammonia, in terms of individual atoms and molecules. This is the microscopic world.

Scientists are often so used to going back and forth between the two views that they don't even realize that they're doing so. An occurrence or observation in the macroscopic world generates an idea related to the microscopic world, and vice versa. You may find this flow of ideas disconcerting at first. You may have noticed this back and forth some in your Chemistry I studies; you'll notice it more in your Chemistry II studies. You may need some adjusting to it before moving back and forth becomes second nature to you.

Contrasting pure and applied chemistry

In *pure chemistry,* chemists are free to carry out whatever research interests them — or whatever research they can get funded. There is no real expectation of practical application at this point. The researcher simply wants to know for the sake of knowledge. This type of research (often called *basic research*) is most commonly conducted at colleges and universities. The chemist uses undergraduate and graduate students to help conduct the research. The work becomes part of the students' professional training. The researcher publishes his or her results in professional journals for other chemists to examine and attempt to refute. Funding is almost always a problem, because the experimentation, chemicals, and equipment are quite expensive.

In *applied chemistry,* chemists normally work for private corporations. Their research is directed toward a very specific short-term goal set by the company — product improvement or the development of a new plastic or medicine, for example. Normally, more money is available for equipment and instrumentation with applied chemistry, but the chemists also have the pressure of meeting the company's goals.

These two types of chemistry, pure and applied, share the same basic differences as science and technology. In *science,* the goal is simply the basic acquisition of knowledge. There doesn't need to be any apparent practical application. Science is simply knowledge for knowledge's sake. *Technology* is the application of science toward a very specific goal.

Society has a place for science *and* technology — likewise for the two types of chemistry. The pure chemist generates data and information that is then used by the applied chemist. Both types of chemists have their own sets of strengths, problems, and pressures. In fact, because of the dwindling federal research dollars, many universities are becoming much more involved in gaining patents, and they're being paid for technology transfers into the private sector.