

Why Study Chemistry?

In This Chapter

- ◆ What chemistry is good for
- ◆ Why you might hate chemistry
- ◆ Why you shouldn't hate chemistry
- ◆ The origins of chemistry
- ◆ How to learn chemistry

When most people think of the word “chemistry,” they think of a sinister old man in a white lab coat giggling evilly over a bubbling beaker. This image probably comes from movies and television, which usually portray chemists as the creators of terrible monsters, world-destroying super-weapons, and insects that grow to abnormal sizes and terrify the residents of small towns in Texas. Fortunately, in recent years, the media has revised their former image of chemists—we’re now sometimes depicted as senile rather than insane.

In any case, most people put off taking chemistry until the last possible minute, the same way most of us put off root canal surgery until flames start shooting out of our teeth. Don't worry if you're in the same boat. Historically, chemistry has been a source of stress since the times when it was first realized that mixing chemical A with chemical B formed a green powder that fended off witches. Fortunately, recent discoveries indicate that witches don't exist.

Why Do We Need Chemistry?

“Chemistry” is a hard word to define. Some chemistry textbook covers show pictures of bubbling flasks, suggesting that chemistry can be defined as “the study of how we can make things behave if we mess with it in the laboratory.” Other chemistry books have pictures of huge molecules on the cover, suggesting that chemistry is defined as “the study of how we can cram atoms together to make big complicated structures.” I’ve even seen a textbook cover that featured a multicolored squiggle. I have no idea what that says about the study of chemistry.

It seems to me that if we put these two definitions of chemistry together, we get a reasonable idea of what the subject actually entails. Chemistry can be defined as using our knowledge of how matter is put together and how it interacts with other matter to solve confusing problems.



The Mole Says

The best way to understand chemistry is to translate the big words into more easily understood terms. By translating scary 10-syllable words into easy 2-syllable words, you’ll have a much easier time understanding the topic being studied.

Some of the confusing problems that you’ll have to solve can be found in any chemistry textbook (including this one). A typical example:

“What is the volume of 556 grams of steam at a temperature of 2300° Celsius and a pressure of 35.40 atmospheres?”

You’re already painfully aware that these problems aren’t important in our everyday lives. When will you ever need to find the volume of 556 grams of steam under the conditions indicated in the problem? Probably never.

So the obvious question is this: If I just told you that you’ll never need to solve these problems in the real world, why do you need to learn chemistry?

The reason you have to learn how to solve problems like this is that they really do have applications in the real world. Knowing how to find the volume of 556 grams of steam under extreme conditions may not be something you’ll be doing in the future, but you can bet that if you do anything scientific in the future, the law that allows you to answer this question will come in handy. Like basic arithmetic, basic chemistry is useful because it gives you the tools to solve real-world problems.

What Have I Gotten Myself Into?

At first glance, chemistry doesn't seem like it will be a lot of fun. As an example, flip through almost any introductory chemistry textbook, and you'll find confusing diagrams like Figure 1.1.

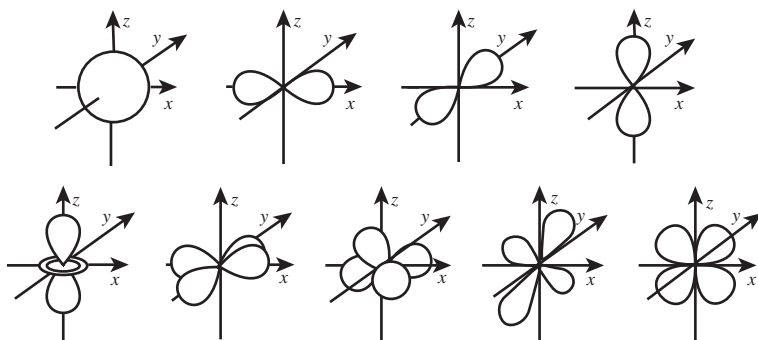


Figure 1.1

These unfriendly looking diagrams give us an idea of what f-orbitals look like.

How the heck are you supposed to understand what this diagram means? Who came up with this stuff, anyway?

Relax. Take a deep breath. The reason you're nervous about taking chemistry is not because chemistry is difficult. The reason you're nervous is that you're trying to wrap your brain around every aspect of chemistry at once. Think back to the first time you learned to add. Wouldn't it have been terrifying to look in the back of the book to find a diagram explaining how to do long division? Take chemistry one step at a time and you'll do much better than if you confuse yourself with things we haven't discussed yet!



Bad Reactions

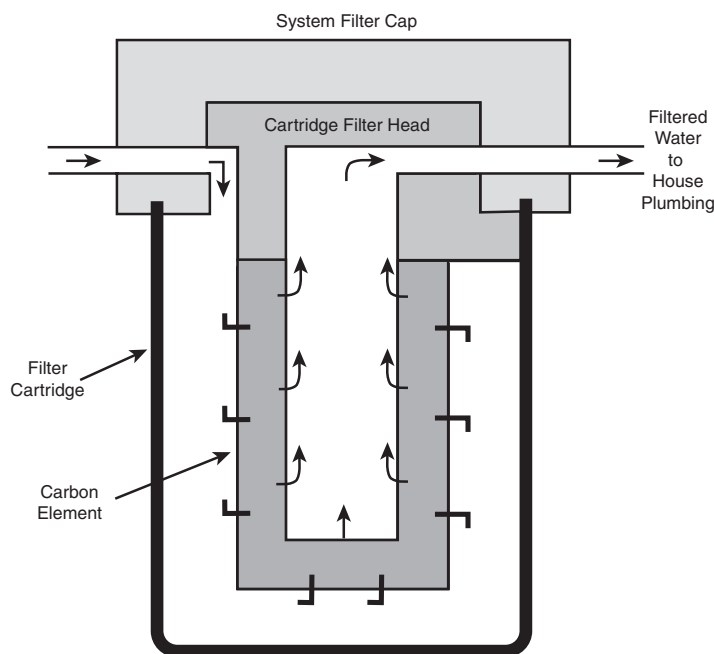
The best way to make chemistry confusing is to wait until the last minute to learn everything you need to know. By breaking the subject into small, easy-to-digest pieces, chemistry becomes much easier to understand.

This Stuff Is Really Fun!

Chemistry is fun! With a good grounding in chemistry, you'll not only understand how to balance an equation and discuss moles like a pro, but you'll also get a better understanding of how real-world phenomena work. For example, take the everyday fish tank filter (see Figure 1.2). Most of us don't give a lot of thought to how the filter works, choosing instead to scrub out the foam sponge and change the charcoal whenever the tank starts looking a little scummy.

Figure 1.2

The foam rubber filters solid wastes, while the activated charcoal removes liquid wastes.



Though you wouldn't think so by looking at it, the filter uses sophisticated chemistry to keep your fish alive and happy. The first section of the filter contains a foam sponge that allows water to pass through undisturbed but picks up solid fish waste. From a chemist's standpoint, you've filtered the solids from a heterogeneous mixture. The

second section of the filter contains activated charcoal, which serves to remove dissolved fish wastes. From a chemist's standpoint, the activated charcoal selectively *adsorbs* organic compounds, allowing inorganic materials to pass through undisturbed.



Molecular Meanings

When something is **adsorbed**, it has been stuck to the surface of a material. Absorption, with which you are more familiar, is when something has been soaked up into another material.

Okay, so this example won't wow the guests at your next get-together. However, you'll probably find that people are more interested in the science behind everyday objects than they're willing to admit, even if they do claim to hate chemistry.

Who Invented Chemistry?

If you haven't yet been convinced that chemistry is a worthwhile pursuit, you may be wondering who you can blame for its invention. Bad news—you'll have to travel back in time to punch the inventors in the nose, because chemistry has been around for thousands of years.

It's All Greek to Me!

Though it's not entirely clear when people started using chemistry, the first people to record their studies were the ancient Greeks. For this, as well as their many philosophical ponderings, students hate them to this day.

Ancient Greek scientists are primarily known for coming up with the idea of elements as well as early models of the atom. Unfortunately, the limitations of their technology kept them from getting an accurate idea of what these elements were and what atoms really looked like.

Turning Trash into Gold

For a very long time in the Middle Ages, chemistry was a mystical pseudo-science performed by alchemists whose goal was to turn cheap metals such as lead into gold using mysterious chemical processes.

Typically, the works of the alchemists were mystical, involving spells and potions.

Though their science was a little flaky, the alchemists did keep the knowledge of the ancient Greeks alive while adding some touches of their own. Islamic alchemists in particular developed many of the laboratory techniques we use today, most notably the use of distillation to purify liquids.

Chemistrivia

One of the greatest alchemists was Jabir ibn Haiyan, who lived in the eighth century C.E. In addition to his quest to make gold, he wrote about dyeing fabrics, making fabric waterproof, and refining metals.

Chemistry Hits the Big Time

The first modern chemist was Robert Boyle (1627–1691). Though most famous for his work with gases, Boyle was also the first to disagree with the Greek idea of four elements in his book *The Skeptical Chymist*, published in 1661.

Despite his groundbreaking work, Boyle continued to believe that metals weren't really elements and that it would eventually be possible to convert one metal into another using chemical processes. Hey, even the greats sometimes strike out.

Modern Chemistry

Nowadays, chemistry has been converted from a quest to make gold into a big business with hundreds of thousands of chemists working worldwide. However, the quest to make valuable materials continues to be the driving force for modern chemistry.

One of the largest areas of chemical research today is the development of new pharmaceuticals. Because antibiotic resistance is a growing problem when treating many diseases, new drugs are continually being developed. The treatment of the HIV virus has been revolutionized by the use of protease-inhibiting medications. Organ transplants are made possible by the use of anti-rejection medications. Modern medicine simply wouldn't be possible without chemistry.

In fact, most of the stuff around your house benefits in one way or another from the practice of modern chemistry. The food you eat is colored, flavored, and preserved by various chemical additives. The cleaning supplies you use to keep your house from being closed by the health department are manufactured in industrial lots by large chemical firms. The bug killers you use to keep cockroaches from overrunning your kitchen are made in giant labs. Modern life simply wouldn't be possible without the use of chemistry.

Succeeding Where Others Have Failed

Even after reading this chapter, the big question in your mind may be, "Can I really learn chemistry?" The answer: With patience and time, anybody can learn chemistry. In my years of teaching chemistry I've never found anybody who, with a little bit of hard work and study, wasn't able to understand the basics. Of course, there are some things you can do to make this task easier on yourself:

- ◆ *Learn the vocabulary!* As mentioned earlier, chemistry is full of confusing, specialized terms. It doesn't matter how well you've memorized the material—if you don't understand what the words mean, you won't understand chemistry.
- ◆ *Learn processes, not facts!* A lot of people attempt to learn chemistry by memorizing the periodic table, the names and formulas of every chemical compound, and all the equations from the chemistry book. Some of these people learn chemistry, some of them don't, and some of them have heart attacks from all of that memorization. Chemistry becomes much easier if you learn how to solve problems, rather than memorizing the answers to every potential problem. In this book, we'll be discussing methods you can use to solve problems, rather than committing the atomic masses of the lanthanides to memory.
- ◆ *Slow and steady wins the race!* I certainly hope you bought this book sometime in the middle of a chemistry class, rather than the day before your final exam. Like most subjects, chemistry is much easier to understand if you take it in small, easily digested chunks. Remember, it took over 2,000 years to develop modern chemistry—you probably won't become a pro after a 32-hour study session.

- ◆ *Use common sense!* When you solve problems in chemistry, look at the answers to make sure they're right. For example, if you've found that you're 45 meters tall after doing a unit conversion, it's fairly certain you've made a mistake (unless you're the Jolly Green Giant).
- ◆ *Enjoy the scenery!* Though there are some really boring aspects to chemistry, there are also a lot of really neat things to learn. Think of chemistry as being like a long car trip—sometimes you have to endure the traffic in New Jersey before you can enjoy New York City.

Chemistrivia

When I took chemistry for the first time in high school, I barely passed after a great deal of effort. I know how you feel about chemistry and will help you get through the process as painlessly as possible (and with much better results than I had the first time through!).

The Least You Need to Know

- ◆ Chemistry is important because most of the other sciences use it as a tool for solving problems.
- ◆ A good knowledge of chemistry will allow you to understand how many common things work.
- ◆ Chemistry was developed over a very long period of time, but has only in the past two centuries been made into a real science.
- ◆ With patience and time, anybody can learn chemistry.

