# Chapter 1:  Introduction to Chemistry

*There's a lot of chemistry that takes place when you've got a bunch of disgusting hamster cages sitting in your living room.*

*http://commons.wikimedia.org/wiki/File:Hamster_cages.jpg*

# Chapter 1:  Introduction to Chemistry

Take a look around you.  There's chemistry all over the place.  From the houseplant dying on the windowsill to the Red Bull your chemistry teacher guzzles at 6:30 am, chemical processes are everywhere.  In this book, we're going to talk a lot about chemistry, which is why the book is named "*Chemistry:  The Awesomest Science*."[1]

## Section 1.1:  What is chemistry?

**Chemistry** is the study of how one type of stuff is transformed into another type of stuff.  This is done through the making and breaking of chemical bonds.

*Figure 1.1:  An example of some of the stuff that does chemistry.*

http://commons.wikimedia.org/wiki/File:23623_Suurem%C3%B5isa_m%C3%B5isa_allee.jpg

## Section 1.2:  The different types of chemistry:

There are a bunch of different branches of chemistry, classified by the type of thing the chemist does:

- **Organic chemistry**:  The study of stuff that contains carbon, hydrogen, and whatever other elements are handy.  Organic chemists frequently smell bad due to the solvents they work with.
- **Inorganic chemistry**:  The study of the chemical compounds that aren't organic.  These guys do a lot of stuff in materials science, which is important for some reason.
- **Physical chemistry**:  The study of how energy interacts with matter.  They say they study kinetics and thermodynamics, though it looks like they're just goofing around on computers.
- **Analytical chemistry**:  The identification of matter using expensive tools.  These people do a lot of quality control stuff and are the ones who see if your pee test is full of heroin.
- **Biochemistry**:  The chemistry of living things.  Most "biology" is really biochemistry nowadays, which is further proof that chemists are more awesome than biologists.

In reality, all of the branches of chemistry (and of science in general) work together, which blurs the lines between them a lot.  And anybody who tells you otherwise is a big fat liar.

[1] It was originally going to be called "*Chemistry:  Catch the Fever!*" but it sounded too disco.

***Who are scientists?***

***Figure 1.2:*** *Scientists are people who study the world around them using systematic means. Though some scientists look like the traditional "mad scientist", most are just boring looking people who drive Priuses.*

[http://commons.wikimedia.org/wiki/File:Toyota_Prius_NHW20.jpg](http://commons.wikimedia.org/wiki/File:Toyota_Prius_NHW20.jpg)

## Section 1.3: The scientific method:

Contrary to what TV shows, scientists don't just hang around and drink coffee while solving mysteries. Rather, real scientists usually just drink coffee and surf the web. However, when a problem needs solving, they do so in a methodical manner. This has two advantages: It allows scientists to get reliable results and it allows them to go back to drinking coffee sooner.

Scientists study the phenomena around them using the **scientific method**. The scientific method is a systematic way of solving problems or making use of stuff that you accidentally discovered. To perform the scientific method, the following steps are usually undertaken:

- **Purpose**: In addition to getting paid, scientists often have a scientific motivation for studying problems. Maybe they're curing AIDS, or maybe they're just inventing a new method of lethally-injecting death row inmates. Either way, there's a problem that needs solving and they're the ones who need to solve it.
- **Hypothesis**: A hypothesis is a guess about what will solve the problem. Depending on whether or not the scientists know what they're doing, this might be a good guess or it might be a lousy guess. Either way, it gives them somewhere to start.
- **Experiment**: Once scientists have a guess about how to solve a problem, they perform experiments to see if their hypothesis is right. These experiments occur when a scientist manipulates an **independent variable** to change the **dependent variable** of the experiment in a useful way. This needs to be done carefully, or the results will be suspect and the scientists will lose their funding.

- **Results**: What happened in the experiment? Those are the results. Results are also called data. Quantitative data is numerical data (i.e. "The puppies lasted 640 seconds before exploding") and Qualitative data is descriptive (i.e. "The puppies looked really upset before exploding.")
- **Conclusion**: Did the problem get solved? If not, go back to the hypothesis and think of something else. With some luck, you learned enough with your experiment to come up with a better hypothesis this time.

> ***Lucky Discoveries***
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> ***Fortunate accidents*** *are when scientists figure something out more or less at random. Lots of scientific stuff gets discovered this way, such as the discovery of penicillin, the discovery of Teflon, and the discovery of vulcanized rubber. Though it looks like the scientific method doesn't play a role in this, once these folks made their mistake they were able to study it in detail using the scientific method so they could figure out what they did.*

## Section 1.4: Hypotheses, Theories 'n' stuff:

When somebody is trying to figure out the answer to a problem, they try to solve it. Or they go and watch TV. It really depends on who you're talking about.

Anyhow, let's imagine that we're talking about a scientist. If the scientist observes something cool, they may come up with a **hypothesis** about the observed thing – this hypothesis is a guess about what's happening that's testable with an experiment. Assuming the hypothesis is correct, the scientist may or may not have enough information to build a **model** to explain the phenomenon. Further testing of this model via different hypotheses is then required to see if it actually works most or all of the time.

When a model gets confirmed over and over again by experiment, it becomes a **theory**. Theories are well-developed and widely-accepted explanations of how something happens. When you write a theory, chances are that you need a big book full of references to explain what the heck you're talking about. Also, contrary to popular belief, a theory isn't some wild guess about something – it's something that has been tested and proved correct a whole bunch of time.[2]

A **law** is when you've got some nice numerical way of describing what will happen under some set of circumstances. This doesn't take a whole book to write – it's usually something simple that identifies the relationships between things.[3]

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[2] Such as the theory of evolution. Biological scientists believe this is true, and there have been no counterexamples discovered yet.

[3] A theory and a law are two totally different things. A theory explains *why* things happen, while a law is a simple statement that tells you *what* happens. Theories don't become laws over time, but they may be used to explain why laws are correct.

## Section 1.5:  How scientists learn stuff:

Because lots of people have lots of problems, there are lots of scientists doing lots of research.  Some of this research is really cool, while other experiments are boring.  Either way, there are a lot of things to discover, and as long as the checks continue to clear, there will be scientists to discover them.  Here are some of the ways that research is performed:

- **Pure research** occurs when people try to figure stuff out just for fun.  Lots of pure research is done at universities, where graduate students study things they don't really care about so they can one day get academic jobs and make *their* students study things they don't care about.

- **Applied research** is when scientists are given a problem and told to solve it.  This happens in industry, where the people in charge hope to make a bucket of money off of the scientists' discoveries.


***Figure 1.3:*** *The development of Viagra and its subsequent use in helping certain people with a certain medical problem that we don't really want to get into is an example of applied research.*
*http://commons.wikimedia.org/wiki/File:Viagra_in_Pack.jpg*

## Section 1.6:  The Lab and You – How Not To Kill Yourself

In this class, you're going to be messing around in the lab like a real scientist.  And just like a real scientist, you run the chance of maiming yourself in an interesting and painful way if you screw up.  To avoid such unpleasantness, you need to follow these lab rules:[4]

- **Know what you're doing before you do it**.  If you don't know how to do something, stop and figure it out before you do it.

- **Use common sense to avoid idiotic mistakes**.  If you have to ask whether something is idiotic before you start, it probably is.  Wrestling, burning stuff, drinking things, throwing things, poking people, stealing chemicals, and other stupid things fall under this category.

[4] There are more comprehensive lists of safety rules all over the Internet.  However, these rules pretty much sum up their meanings in a much briefer fashion.  If you want to see a more conventional and complete set of rules, you can find about a million of them up on Google.

- **Wear goggles**. If you don't wear goggles and something gets in your eye, you will be blinded. Seriously. There's one thing I never joke about, and this is it.[5]

- **Dress appropriately**. Make sure your clothes cover you adequately, that they're not super loose, and that they won't get stuck in a Bunsen burner when you lean over. And girls, knock it off with the short skirts. They make your male teachers uncomfortable.

- **Know where the safety equipment is and how to use it during emergencies**. Don't, however, use it unless you've got a good reason – being bored is not a good reason.

- **Report accidents and such to your teacher**. He or she will then probably take the appropriate action.

- **Don't put stuff in your mouth**. This includes food, drink, chemicals, your fingers, and so forth.

- **Be careful around fire**. Don't burn stuff you're not supposed to. Don't keep flammable things around flames. Don't lean over the fire. Don't leave the Bunsen burner unattended. And don't put hot glassware in water, because it will break and annoy your teacher.

***Figure 1.4:*** *An example of poor fire safety.*

*http://commons.wikimedia.org/wiki/File:FirePhotography.jpg*

- **Use the right equipment for the job**. That means no weighing stuff in graduated cylinders or using beakers to find volumes.

- **Toxic gases belong in the fume hood**. God only knows where they go after they get blown out of the room, but that's not really our problem.

- **Waste and broken stuff belong in the containers marked "waste" and "broken stuff", respectively**.

- **When diluting acids, add acid to water**. But only if it's necessary. Don't just go adding acid to water for no reason, because that's annoying.

- **If you weigh stuff, weigh it on a watch glass**. That's what they're there for.

- **Put everything away when you're done**. I'm not your mom, after all.

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[5] For an interesting story about a bunch of kids who got fried, visit http://www.dep.state.pa.us/dep/deputate/pollprev/sitevisit/Case1.pdf.

## *Chapter Summary*

- Chemistry is the study of how one type of stuff becomes another kind of stuff.
- Physical chemists probably just play video games all day, but nobody can prove it for sure.
- The scientific method is a good way of figuring stuff out.
- If a scientist tells you that something is either a theory or a law, you'd better listen to him because it's probably right.
- Pure research is done for the love of discovery. Applied research is done for the love of money.
- Lab rules are really important to follow if you plan on living a long life. Wearing goggles in the lab is the single best thing you can do to prevent horrible injuries.