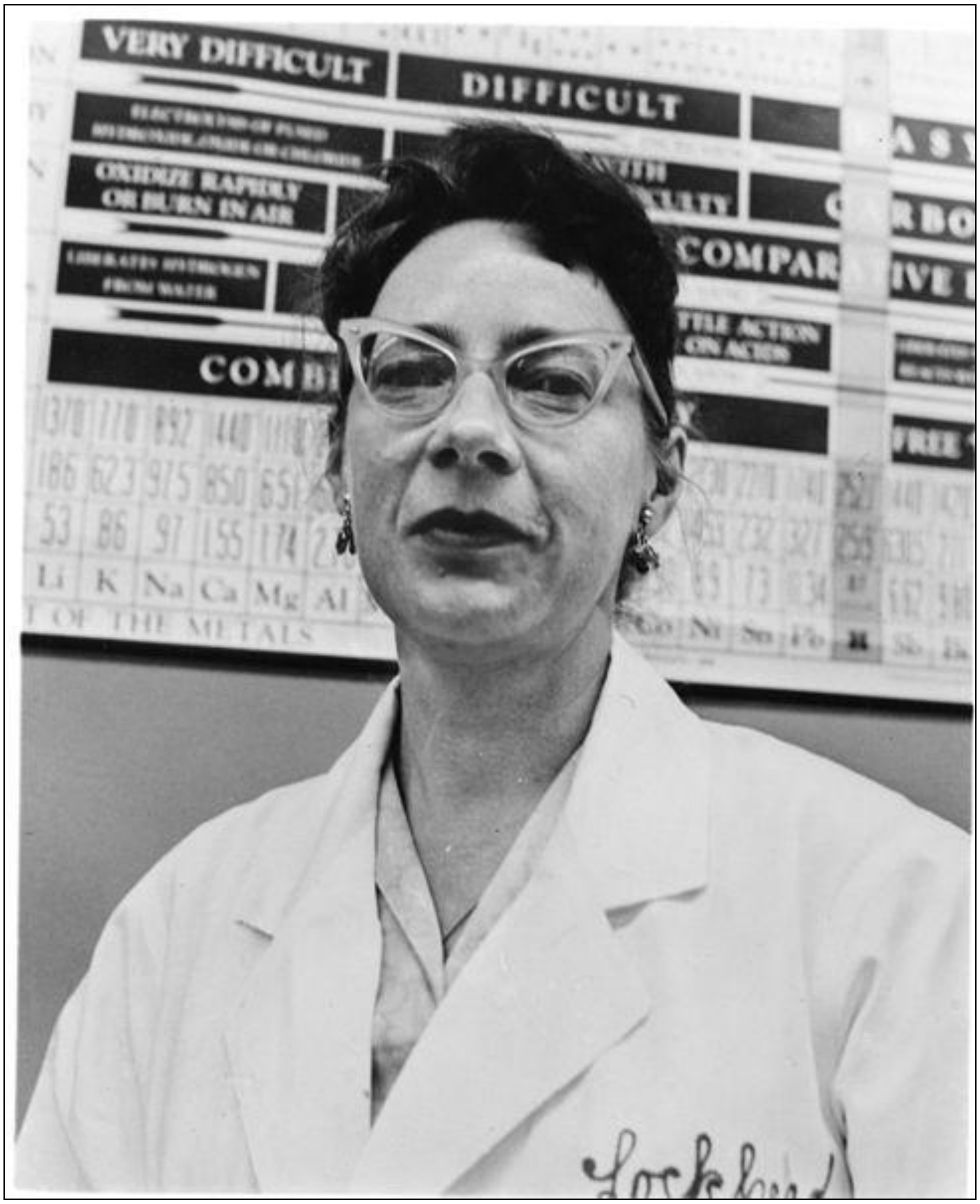
Chapter 7: A Whole Bunch of Elements



Scientist Wanda G. Bradshaw contains a whole bunch of elements.

http://commons.wikimedia.org/wiki/File:Wanda_G._Bradshaw_(3379012634).jpg

Chapter 7: A Whole Bunch Of Elements

There are a whole bunch of elements. You can tell this by looking at the periodic table – there are literally lots of elements that are listed on the table. These elements are the basic building blocks of matter, unless you include subatomic particles, in which case they aren't.[1]

Section 7.1: Hydrogen, Alkali Metals, and Alkaline Earth Metals

In this section, we'll talk about the elements in the first two groups of the periodic table. Because they're the first ones on the left side of the table, it's particularly important that you are familiar with them. Like *A Tale of Two Cities*, the first part is the most important because it's the only part that people read before they get bored and buy the Cliffs notes.

Figure 7.1: *Charles Dickens at work on one of his books. As you can see, he didn't find them any more interesting than the rest of his readers.*

http://commons.wikimedia.org/wiki/File:Dickens-at-the-Blacking-Warehouse.jpg

Hydrogen:

The whole universe is chock full o' hydrogen. Seriously, if you go into space, you'll probably bump into a bunch of hydrogen asking for spare change.

Hydrogen has only one valence electron, so it does weird chemistry. It can either gain electrons to form the H^- ion or lose electrons to form the H^+ ion. When you've got a bunch of gaseous hydrogen sitting around in big balloons, nothing much happens until you add energy – then it explodes. Think of hydrogen as the inexplicably cranky uncle of the periodic table family: It's happy to sit quietly at the dinner table until it starts suddenly ranting about "them Commie bastards."

Spotlight on the Elements: Hydrogen

Industrially, hydrogen is really important. It's used make stuff like cooking oil and fertilizer, and used to be used in children's balloons until they started blowing up all over the place. They even used it to fill big blimps called zeppelins until the *Hindenburg* blew up in 1937. Then they got the idea that it wasn't that smart and decided that airplanes would be better.

[1] But as chemists we pretend that anything smaller than a proton, neutron, or electron doesn't exist, and even then, we usually ignore anything smaller than an atom.

Group 1: Alkali Metals

The alkali metals are really cool, but you probably won't get to play with them much in class. This is because, in addition to their properties of low melting and boiling point and softness, they also blow up when you put them in water.[2] Alkali metals form +1 ions when they react, which reflects the fact that they want to lose one electron to be like the nearest noble gas. Solutions made with these elements are basic, which is another way of saying "alkaline", which is pretty close to the world "alkali", which is where they get their group name.[3] Here are some alkali metals and their main uses:

- Lithium is used to make batteries and treat the mentally ill (Figure 7.2).
- Sodium is in table salt, which can be used for a bunch of different stuff. It's also really important in biochemistry, so you might want to check that out.[4]
- Rubidium cesium, and francium are all really super dangerous and react with almost anything. We don't use them because we value our fingers, which would probably be lost if we screwed around with them.

Spotlight on the elements:

Figure 7.2: *Lithium is found in lithium carbonate, which is used to treat bipolar disorder (which is sometimes also known as "manic depression." Nobody really knows why lithium carbonate works, but it seems to do the trick for a lot of folks.*

http://commons.wikimedia.org/wiki/File:Lithium_carbonate.jpg

Group 2: Alkaline Earth Metals

Alkaline earth metals are like alkali metals, except that their properties aren't as extreme. For example, they're reactive, but they don't blow up in water (calcium does, however, kind of fizz a little). They have low melting and boiling points, but not really all that low. They do form ions with a +2 charge, which reflects their desire to lose two electrons to be like the nearest noble gas.[5] Let's check out some of the most interesting alkaline earth metals:

[2] If you can get your hands on a sample of the alkali metals, don't blow it up. These things are truly dangerous and can cause massive injuries. Just go to You Tube and look up the videos instead.
[3] This is, believe it or not,completely true.
[4] Ask a biochemist about this, because that's the kind of stuff they work on.
[5] That's the octet rule in action!

- Magnesium is a strong and light element, and it totally burns like crazy when you light it on fire. This element can commonly be found in the rims of the expensive sports cars driven by middle aged men having a midlife crisis.[6]
- Calcium is found in bones[7] and rocks. Shells are mostly made of calcium, too.
- The other alkaline metals do stuff, too, but most of that stuff isn't really all that interesting.

Awesome Women of Science

Figure 7.3: *Marie Curie was a super-awesome scientist who won two Nobel Prizes for her work with radioactive materials. Unfortunately, despite her Rutherford-level awesomeness, she was murdered by these sinister radioactive compounds (including the alkaline earth metal radium) in 1934. After her death, it was discovered that all of her possessions were so radioactive that people who wish to see them even now need special protective gear.*
http://en.wikipedia.org/wiki/File:Marie_Curie_c1920.png

Section 7.2: Elements in the p-block (Groups 13-18)

Elements in the p-block are a mixed bag. Some are metals, some are nonmetals, and some are metalloids. If you're looking for an element with some property in particular, look no further than the p-block. Because books usually have lots of words written in them, let's write some words about the p-block elements.

Group 13: Boron's Group

The elements in boron's group don't have much in common with each other because boron is a metalloid and the rest are metals. Aluminum is probably the most important element in this group, being widely used to make aluminum cans, industrial stuff, and deodorant.

Group 14: Carbon's Group

Carbon is a really important element that's present in all biological systems. It's commonly found as one of three allotropes:[8] as **graphite** (a black sooty form), **diamond** (a really pretty clear form), and

[6] That is, those who aren't driving Hummers instead.
[7] It's found in bones, but not in the form of the pure element calcium (which reacts vigorously with water). Instead, it's found as calcium phosphate.
[8] Forms of an element.

fullerenes (a form that's also black and sooty). Other important elements in this group include silicon (a metalloid that's used to make computer chips), lead (which is used to make fishing weights and used to be used to make paint that contributed to the stupidity of small children), and tin (which is used to make solder and pewter). Silicon is a metalloid in this group and is used to make computer chips and sand. Lead is used to make batteries, and tin isn't really used for that much anymore except in the manufacture of those pewter figurines your grandma is so fond of.

Figure 7.4: *This man believes that his tin-foil hat will keep the government from reading his thoughts. Unfortunately, modern "tin foil" is actually made of aluminum, which unlike tin fails to stop brainwave-monitoring surveillance.*

http://commons.wikimedia.org/wiki/File:ManWearingTinFoilH

Group 15: The Pnictogens[9]

The pnictogens don't have much in common with each other because some are nonmetals, some are metalloids, and one is a metal. Nitrogen is used to make fertilizer and explosives[10], as well as industrial nitric acid. Phosphorus is really reactive and is used to make matches and cleaning materials. Arsenic is poisonous, antimony isn't used for that much, and bismuth is used to make Pepto-Bismol.[11]

Group 16: The Chalcogens[12]

Oxygen is required for stuff to burn and also for animals to breathe. There's a lot of it in our atmosphere, which is good news for us. Sulfur smells bad and is used to make sulfuric acid, and both selenium and tellurium are used in semiconductor production.

Group 17: The Halogens

The halogens are all unbelievably reactive. Fluorine is the most electronegative element so it will instantly strip electrons off of almost anything it comes into contact with, and the other halogens pretty much do the same thing, too. These elements are also pretty good at killing living creatures, which can be

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[9] "Pnictogen" is Greek for "the group with nitrogen at the top."
[10] And no, I'm not going to tell you how to make them, so quit asking already.
[11] This is that pink goo your mom makes you drink when your tummy gets yukky. Its official chemical name is bismuth subsalicylate.
[12] "Chalcogen" is Latin for "the group with oxygen at the top."

both good (when used to kill microorganisms in water) or bad (when used as chemical weapons). Overall, it's usually a good idea to stay away from these chemicals unless you've got a pretty good reason to do so.

Group 18: The Noble Gases

If you think way back to the last chapter, you'll remember the octet rule.[13] If you don't remember it, here it is again: All elements want to gain or lose electrons to get the same number of electrons as the nearest noble gas.[14] The reason we care about this when talking about the noble gases is that this law is based on the idea that elements with the same electron configurations as noble gases are really, stable. Given that these elements *are* noble gases, you can guess that they're very stable, indeed.

Figure 7.5*: Neon is used in the manufacture of "neon signs." Until 1978, all neon signs were required to have this shape so people wouldn't confuse them with signs containing other elements.*

http://commons.wikimedia.org/wiki/File:NeTube.jpg

Basically, the noble gases are used for a whole bunch of stuff – what these uses have in common with one another is that they require the gases to be completely unreactive.[15] Argon is one of the most commonly-used for this purpose, being found between panes of glass in fancy windows and in glove boxes where air-sensitive chemistry is taking place.

Section 7.3: The Transition Metals

The elements in groups 3-12 and the two rows at the bottom of the periodic table are referred to as the **transition metals**. It's not clear what transition is being made, but presumably this had some significance at the time these groups were named.

Talk Like a Real Chemist!

Though the term "transition elements" technically refers to the d-block elements (which are the "outer transition metals" and the f-block elements (which are the "inner transition metals"), nobody actually ever uses these terms in the real world. If you want to sound like a real science guy, use the term "transition metals" to refer to the d-block and just call the groups on the bottom the "lanthanides" and "actinides."

[13] If you don't remember it, then you'd better learn it, because it's going to keep coming up later in the book.
[14] Seriously, learn this. It's really important.
[15] This is why balloons at childrens' parties are filled with helium and not hydrogen.

The d-block Transition Metals

So, I was listening to some scientific experts[16] and they spoke about where the transition metals come from and what each one is used for and stuff like that. However, after some thought, it occurred to me that none of that is really all that important to know. So, instead of throwing ten pages of *The Story of Pig Iron* at you, here are the important things you need to know:

- Some transition metals can form ions with more than one charge. Iron, for example, can form both the Fe^{+2} and Fe^{+3} ions, depending on what you do to it.
- Iron, nickel, and cobalt are all magnetic.
- Steel is mostly iron, with a little bit of carbon and other elements added to make it stronger and more corrosion resistant.
- Transition metals are used to make practically everything.[17]

Spotlight on the Elements

Figure 7.6: *This robot DJ is made mostly of transition metals. The use of these metals allows machinery to function more effectively. Some of these tasks include construction, aerospace applications, and the destruction of the human race.*

http://commons.wikimedia.org/wiki/File:Robot_DJ.jpg

The Lanthanides and Actinides

The lanthanides and actinides are given these names because one of the rows starts with lanthanum and the other starts with actinium. The lanthanides are used in optical coatings (such as shiny sunglasses and other lenses) while the actinides are used in nuclear power plants, atomic bombs, and smoke detectors.

Figure 7.7: *Actinide being used during Operation Sandstone at the Enewetak test range in 1948.*

http://commons.wikimedia.org/wiki/File:Operation_Sandstone_003.jpg

[16] The Mythbusters.
[17] If anybody ever asks you three things that transition metals are used for, just say random stuff and you'll be fine.

Chapter Summary

- Elements in the same group of the periodic table have similar properties because they have the same number of valence electrons.
- There are a lot of groups in the periodic table and you should probably be somewhat familiar with their properties.
- If people ask you what transition metals are good for, just mention something industrial and they'll nod and smile.

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