

## Early atomic theory:

If you're reading this tutorial, you've been told that you'd better learn about atomic theory. And, if you're like me, you're not that excited about it.

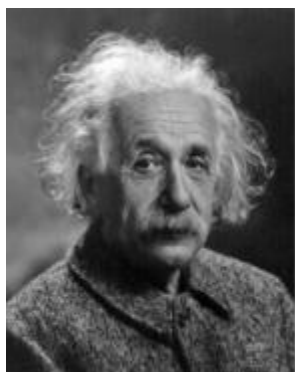
Fortunately for you, I'm writing this tutorial and I'd like to make it as interesting as I can while remaining informative. Hopefully, when you're done reading this, you'll be an atomic theory superstar. Or something.

I'll include the occasional [footnote](#) in the text so you can learn more about what I'm saying. These things are usually not vital to understanding the material, but might be interesting for those of you who want to learn some of the more random bits of knowledge.

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## Why do we need to learn the history of the atom, anyway?

Firstly, you need to know the history of the atom because the current model is a little hard to understand. Instead of just beating you over the head with quantum mechanics, we're going to work up to it gradually, just as people did in the past. Heck, even smart guys didn't really understand quantum mechanics.



**Figure 1: This guy got into a bunch of fights about quantum mechanics with a guy named Neils Bohr. He lost, because he totally wasn't smart enough to understand what was going on. Loser.**

*Image of Einstein is in the public domain. Feel free to draw a mustache on him or something.*

Secondly, a lot of the ideas from long ago are still used as convenient shorthand to explain chemistry. If you don't know this shorthand, you won't know what's going on.

Finally, your textbook, your school, and the Department of Education think you need to know the history of the atom. You should listen to them if you want to pass this class.

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## Greeks from a long time ago: Leucippus (and Democritus, sort of)

A long time ago, in a land named Greece, there were a bunch of people called Greeks. They thought about pretty much everything, including the nature of matter.<sup>1</sup>

One dude named Leucippus theorized that atoms were indestructible little particles that made up everything. By packing together in different ways, they could make different materials. Though Leucippus did all the work on this theory (the one that's in your textbook), his student Democritus usually gets credit for it because historical records weren't all that clear to historians a few hundred years later.<sup>2</sup>



Figure 2: A picture of Democritus giggling at somebody's skull. What a weirdo.

*Public domain image originally painted by somebody who clearly thought Democritus was nuts*

### Science gets crazy: New discoveries that started new ideas

For a very long time after the Greeks did their talking about the atom, everybody was cool with what they had to say. After all, they said a lot of smart-sounding things and everybody respects people who sound smart.

However, in the 17th century, things changed. This dude named Martin Luther decided that he wasn't happy<sup>3</sup> with the Catholic church and challenged its authority. They yelled back and forth for a while until the church booted him out, and he started his own church so he could do whatever he wanted. And with that, the Protestant Reformation started.

That wasn't all. When people realized that there was an alternative to one established way of thinking, they started realizing that there were alternatives to everything. This caused them to start trying to figure things out for themselves, both in philosophy and the sciences. And with that, started the Enlightenment.

And with *that*, experimental science was born. Which led to:

- **The law of conservation of mass** (Lavoisier): Whenever you do a reaction, the mass of what you make (the products) is the same as the mass of what you started with (reagents). Though this seems obvious, imagine burning a log. If you start with 1 kg of wood, you might have only 200 grams of ashes left afterwards, leading you to believe that the mass disappeared. Though we know the mass wafted away as carbon dioxide, water, and smoke particles, that realization took a long time for humanity to figure out.



Figure 3: An experiment to try at home!  
To prove the law of conservation of mass, burn down a log cabin in your neighborhood and collect all of the combustion byproducts. Done correctly, the mass of the unburned cabin will be the same as the mass of the ash and smoke.

*By Ammodramus (Own work) [Public domain], via Wikimedia Commons*

- **The law of definite composition** (Proust): This was also referred to as the law of definite proportion. Though originally phrased in boring terms<sup>4</sup>, the basic idea behind this law is that, no matter how you make a compound, it's still got the same formula. Put another way, if you make sodium chloride via two different methods, it will have the same formula either way. You'd think this would be a no-brainer, but when you consider that different processes will result in products of different purities (and correspondingly different properties such as color), it's not as obvious as it looks.

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### **Finally, we know what an atom is! Dalton's atomic theory:**

Over the first bunch of years of the 19th century, an English guy named John Dalton came up with an explanation that he believed explained everything you need to know about atoms. Of course, he was wrong, but it was the 19th century, and people back then were kind of dumb.<sup>5</sup>



Anyhow, here's what he came up with:

- **Everything is made of atoms.** Dalton definitively said that matter consists of very small particles called atoms. This is true.
- **All atoms of the same element are identical in every way.** This is a pretty good approximation, as all atoms of the same element have the same number of protons. However, all elements have different forms of atoms referred to as isotopes, in which the nuclei contains different numbers of neutrons. This usually has a fairly [small effect](#) on the properties of the elements, but definitely keeps these atoms from being identical.
- **All atoms of different elements are different.** This is true, because all atoms of an element have identical numbers of protons. By definition, this means that atoms of different elements have different numbers of protons, which clearly makes them different.
- **Atoms are indestructible.** In other words, if you've got an atom, you can't ever break it into smaller pieces – that's as small as things can get. In chemistry, this is absolutely true because the formation and breaking of chemical bonds has no effect on the nucleus of an atom. However, physicists can use particle accelerators and other fancy machines to break atoms into [quarks, leptons, bosons](#), and [magical fairies](#).<sup>6</sup>
- **Atoms combine in whole-number ratios.** In other words, you can't have half an atom. You can have  $\text{H}_2\text{O}$  or  $\text{H}_2\text{O}_2$ , but you can't have  $\text{H}_{2.2}\text{O}$ , because that would mean that you had an uneven number of hydrogen atoms. This is the gist of what Dalton said (though he said it in a way more complicated way) and is referred to as the *law of multiple proportions*. This rule is basically true, though if you want to read more click on the little "7" over here: [7](#)
- **In chemical reactions, atoms are rearranged.** Actually, it's probably more correct to say that the connections between atoms are rearranged, because there are reactions where the atoms stay in one place but the bonds go moving around.<sup>8</sup>

And with that, the world of chemistry was forever changed. Well, it was changed until less than a hundred years later, when it got all crazy again with Thomson and Rutherford and Bohr and stuff. But that's something we'll worry about later.