

## Chemistry Lecture #16: Dalton's Atomic Theory

Our modern view of the atom did not begin until John Dalton began his work in the early 19<sup>th</sup> century. Before this time, people held the views created by ancient Greek philosophers.

Empedocles (492 BCE-432 BCE) believed that matter was made of earth, air, fire and water. The ratio of these materials in a sample of matter determined the properties of the matter.

For example, stone was mostly made of earth. A rabbit, on the other hand, is made of earth and water. This would explain why a rabbit has blood inside of it, while a stone has little or no fluid.

But there was a problem with Empedocles' idea. If you were to cut a stone in half over and over again, all you get are smaller and smaller pieces of stone. Where's the air? Where's the fire and water?

Democritus (460 BCE-370 BCE) suggested that if you cut matter in half over and over, you eventually reach an indestructible particle called an *atom*.

Each substance is made of its own unique type of atom. A rock is made of rock atoms. Wood is made of wood atoms and so on. This would explain why you keep getting smaller and smaller pieces of stone if you keep cutting it in half.

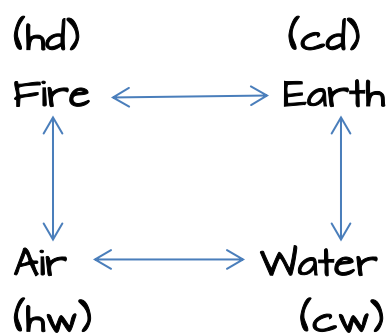
Democritus also believed that one type of atom could not be changed into another type of atom. You can't change a stone atom into a wood atom.

But there was a flaw in Democritus' ideas. If matter was made of atoms, what holds the atoms together?

Aristotle (384 BCE - 322 BCE) completely disagreed with Democritus. He said that matter was continuous (which means you could cut it in half continuously and never reach an indestructible particle).

Furthermore, the real elements of nature were (h)ot, (c)old, (w)et and (d)ry. When these elements were paired in certain combinations, you get earth, air, fire and water. For example, fire was made of (h)ot and (d)ry, and earth was made of (c)old and (d)ry.

He also said that earth, air, fire and water could be transformed into each other by reducing one element and increasing another.



So according to Aristotle, atoms did not exist, and one type of matter could transform into another type of matter (such as

turning lead into gold or fire into matter). Aristotle's influence predominated until Lavoisier (1743-1794) proved the Law of Conservation of Mass.

The Law of Definite Proportions and the Law of Multiple Proportions gave further evidence that matter was made of atoms. All of these laws suggested that tiny particles were simply moving from one location to another in chemical reactions.

To explain these laws of matter, English chemist John Dalton (1766-1844) created a theory of matter.

### *Dalton's Atomic Theory*

1. All elements are composed of tiny indestructible particles called atoms.
2. Atoms of the same element are identical. Atoms of different elements are not identical. For example, all oxygen atoms are the same, but an oxygen atom is different from a hydrogen atom.
3. Atoms of different elements can combine in whole number ratios. This explains the laws of definite and multiple proportions.

4. (a) Chemical reactions occur when atoms are separated, joined, and rearranged. This explains the Law of Conservation of Matter.
- (b) Atoms of one type of element cannot be changed into a different element. This explains why lead cannot be turned into gold.

Dalton's work laid the foundations of modern chemistry.