Module 3: Atoms and Molecules

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1 Overview

1. the **Law of Mass Conservation** says matter can't be created or destroyed
2. **Elements** are the color palette for matter
3. **Compounds** are made of elements that are chemically combined
4. the **Periodic Table** is a thing of rare beauty that will haunt your dreams

2 Mass Conservation

Law 1 (The Law of Conservation of Mass) *Matter cannot be created or destroyed, it can only change forms.*

- this is another conservation law, like the energy conservation law in Module 2
- we can't actually create matter, and we can't actually destroy it, all we can do is convert it from one form to another [1]
- we can convert matter with chemical processes (*e.g.* we can burn wood or wax)
- we can change the state of matter with physical processes (*e.g.* we can freeze water to make ice or evaporate water to make water vapor)
- but we generally can't make more of it, and we can't make less of it

[1] OK, so this isn't *exactly* true: Lavoisier (1743 – 1794) came along when people were still trying to digest Newton (1642 – 1727), they weren't ready for Einstein (1879 – 1955) yet. Let's leave this one here for now, but you should be aware that nuclear reactions really do convert matter into energy.

3 Elements

Definition 1 (Decomposition) *Decomposition is breaking down a substance into two or more other substances.*

Definition 2 (Element) *An element is a substance that cannot be decomposed into a less massive substance.*

- **decomposition** is breaking down a substance into other substances
- many (most) substances can be decomposed, but some cannot
- substances that cannot be decomposed are called **elements** [Wile, 2003, p. 74]
- every physical thing is made up of one or more elements:
  - water is made up of two gasses: Oxygen and Hydrogen
  - sulfuric acid is made up of three gasses: Hydrogen, Sulfur, and Oxygen
  - steel is made up of two solids: Iron and Carbon
  - Iron is made of Iron — it's an element [2]

3.1 The Periodic Table

- each entry in the Periodic Table contains four pieces of information:
  1. the element's **symbol** (*e.g.* H, He, Li, Be, B, C, ...)
  2. the element's **atomic number**
  3. the element's **atomic mass**
  4. the element's location on the chart
- in general terms, the element's symbol acts as a mnemonic, although they don't always work the way we might think (why is lead called "Pb"?)
- the atomic number is unique: it's the defining feature of an element[3]
- we'll get to the atomic mass later
- be aware that not all the elements occur naturally [Wile, 2003, p. 76], there are more elements now than when I was in school(?!)

[2] It's iron all the way down!

[3] On some Periodic Tables, you'll see Hydrogen (H) listed twice, because Hydrogen is weird.

- elements on the *left* of the Periodic Table are metals; elements on the *right* are non-metals, *except Hydrogen (H)*[4]

4 Compounds

Definition 3 (Compound) *A compound is a substance that can be decomposed into elements by chemical means.*

Law 2 (The Law of Definite Proportions) *The proportion of elements in any compound is always the same.*

- there are basically two types of matter: elements and compounds
- a compound is a substance made up of elements (*e.g.* water, steel, sulfuric acid)
- note compounds are made of elements combined *chemically*: bolting a piece of Iron to a piece of Tin doesn't make a compound
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References

[Wile, 2003] Wile, D. J. L. (2003). *Exploring Creation with Chemistry.* Apologia Educational Ministries, Inc., 2 edition.

[4] I told you Hydrogen is weird.