1.1: A Particulate View of the World - Structure Determines Properties

Matter is anything that occupies space and has mass. Matter has bulk properties that we can directly observe and investigate. For example, why is water a liquid at room temperature and at atmospheric pressure? What makes a drug effective or toxic? Why is steel a strong solid and not a liquid like mercury? Why can we ignite a hdryogen gas, but not helium (Figure 1.1.1)?

Figure 1.1.1: (left) The hydrogen gas used in the *Hindenburg* Zepplin is a highly flammable gas (Public Domain; Sam Shere via Wikipedia). (right) In contrast, the helium used in the Goodyear blimp is nonflammable and considerably safer. (CC BY-SA 3.0; Hughs via Wikipedia)

To address these questions, we must first understand two fundamentals concepts of matter that underlie all of chemistry.

1. All matter is consist of small particles, which is the basis of modern atomic theory, and
2. The structure of these particles determines the properties that the matter.

A common refrain taught in biology classes is that **Structure Determines Function**. The chemistry-centered reformulation of this concept is that **Structure Determines Properties**, which is a useful theme in chemistry and in fields that chemistry plays an important role including biology, environmental science, biochemistry, polymer science, medicine, engineering, and nutrition among many others. However, what is meant by properties and structure?

Properties are generally separated into either chemical properties (e.g., will a reaction happen and under what conditions will it occur) or physical properties (e.g., what is a substance' melting points, boiling points, solubility). But what we we mean about structure? This is a catch all phrase for the size, geometry and nature of the atoms of the particulates that the matter is composed of. As you progress through the topics of this chemistry text, we will remind you of this central concept and its applications.

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