
Conceptual Chemistry

Chapter 1: About Science

Detailed Chapter Summary

Science is a systematic process for discovering the secrets of nature. There are numerous paths one might follow in doing science, and these paths are spelled out by the “inquiry wheel”. This diagram illustrates essential activities conducted by scientists, such as making observations, performing experiments, and communicating with others. The goal of these activities is to help answer a fundamental broad question that highlights the scientist’s particular interest.

The discovery of the Buckyball is an example of the scientific process. This discovery began with Harry Kroto’s interest in identifying the composition of interstellar dust. This interest led him to collaborate with Rick Smalley and Bob Curl. Together these chemists subjected samples of carbon to the superhot conditions typically found on the surface of stars. They expected to generate carbon compounds that might match the spectral patterns of interstellar dust. Instead, they discovered evidence of a new and previously unknown material, which came to be known as Buckminsterfullerene, or simply, the Buckyball. This led to the development of similar compounds known as nanotubes, which were central to the advent of nanotechnology.

The discovery of the Buckyball also illustrates the relationship between science and technology. Though closely related, science and technology are significantly different. Science is the study of the rules of nature. Technology is the application of this knowledge for practical purposes. Technology can be helpful or harmful depending on how it is applied. The benefits of a technology need to be weighed against the risks. Some level of risk is unavoidable. Ideally, it is up to society to decide when the benefits are worth the risks.

A key component of science is that any experimental result must be reproducible by other scientists. A *hypothesis* is a suggested explanation for an observable phenomenon. A hypothesis becomes a *scientific hypothesis* when, and only when, it can be tested through experiment. Over time, scientists may develop a *theory*, which is a single comprehensive idea that explains all the known experimental evidence. Theories are not fixed. Rather, they go through stages of redefinition and refinement. Today’s theory of the atom, for example, is much different from atomic theories of 100 years ago, yet it is a much more successful predictor of atomic behavior.

Chemistry is the branch of science that focuses on the workings of atoms and molecules, which are the fundamental components of matter. The research projects of most

chemists are examples of *applied research*, which is research focusing on developing the applications of scientific principles discovered through *basic research*. The impact of chemistry on society has been profound. All modern medicines and materials, for example, are made possible through chemistry.

In learning chemistry it is important to have a basic understanding of various physical quantities, including *mass, weight, volume, density, energy, temperature, and heat*. A physical quantity must always include a number followed by a unit that tells us what was measured. Often in chemistry it is necessary to convert from one unit to another. To do so requires that you multiply the physical quantity by a conversion factor, which is described in the Calculation Corner “Unit Conversion.” The technique of unit conversion (also called dimensional analysis) is very important relative to Chapter Sections 7.3, 9.2, and 9.3. If you will be working with these sections of Conceptual Chemistry, then you are strongly advised to master the technique of unit conversion.

While we have your attention, now is a good time to discuss the significance of the questions. We humans don't download information like computers. Rather, it's a bit more complicated. For learning to be durable, we humans need to try our best to articulate that which we think we understand. Thus the value of questions. They may not be comfortable, but they are your friend. They are here to help you. You are wise to try your best to answer questions as they arise—in quizzes, in homework, on exams, in discussions, in labs, with classmates, with your instructor, with friends and family, or wherever. As discussed within the first podcast episode, when it comes to learning effectively, questions are your friend.