Chapter 1

About Science

THE MAIN IDEA

Science is the study of nature's rules

Λ Our home is a blue marble of a planet covered mostly with oceans. Land makes up only 30 percent of its surface. The atmosphere we breathe is quite thin compared to the size of our planet—about as thin as an apple skin is compared to an apple.

Through science we have learned much about the natural world. For example, we have learned that matter is made of very small fundamental particles called *atoms*. These atoms can then join to form larger fundamental structures called *molecules*. This sort of knowledge has allowed us to create some amazing technologies—from agriculture to medicine to space travel.

Yet science is more than just a body of knowledge. It is also a method for exploring nature and discovering the order within it. **Science** is the product of observations, common sense, rational thinking, experimentation, and (sometimes) brilliant insights. It has been built up over many centuries and gathered from places all around the Earth. It is a huge gift to us today from the thinkers and experimenters of the past.

What is so special about science? Why is science such an effective tool for discovery and for solving problems? How is science different from technology? Why is it so important that each of us have an understanding of this eye-opening and creative human endeavor?

1.1 Understanding the Natural World

We humans are good at observing. We are also good at explaining our observations. What we recognize today as modern science, however, began not with our powers of observation, nor with our creative explanations. Rather, modern science began when people first became skeptical of their observations and explanations. They wondered whether their observations were accurate. They wondered whether their explanations were correct. To resolve their doubt, they turned to *experimentation*.

The greatly respected Greek philosopher Aristotle (384–322 BCE) claimed that an object falls at a speed proportional to its weight. In other words, the heavier the object, the faster it falls. This idea was held to be true for nearly 2000 years, in part because of Aristotle's compelling authority.

READING CHECK

When did modern science begin?

Figure 1.1 >

Place a feather on top of a book. Drop the two together to the floor. Which falls faster: the book or the feather?

The Italian physicist Galileo (1564–1642) was doubtful and allegedly showed the falseness of Aristotle's claim with one experiment—demonstrating that heavy and light objects dropped from the Leaning Tower of Pisa fall at nearly equal speeds. You too can refute Aristotle's claim with a simple experiment, as shown in **Figure 1.1.**

As a practical matter, experiments are better at proving ideas wrong than right. For example, is it a truth that all crows are black? Upon seeing millions of black crows, we may become very confident that all crows are black. The moment we see our first white albino crow, however, this once reasonable idea has been proven false. Of course, learning that our ideas are false is useful information. It can prompt us to double-check our thinking. We can then use our experience and creativity to come up with a more encompassing, alternative explanation. This new explanation may not be perfect, but we can be confident that it is closer to the truth than our previous explanation. The more experiments we conduct, and the more times we refine our explanations, the closer we get to understanding the actual workings of nature.

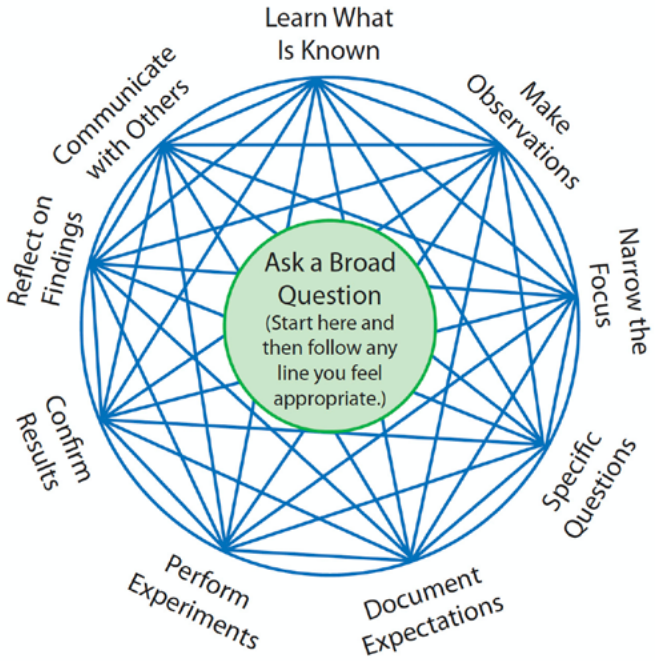
The Wheel of Scientific Inquiry

Performing experiments is just one of many activities that scientists use to reach their goal of better understanding nature. As shown in **Figure 1.2**, one of the first activities tends to be the asking of a broad question, such as "Where did the Moon come from?", "Can we efficiently create hydrogen from water using direct solar energy?", or "When did humans first arrive in North America?" All other activities are guided by this broad question. These activities will likely include learning about what is already known, making new observations, narrowing the focus of the research to something manageable, asking specific questions that can be answered by experiment, documenting expectations, performing experiments, confirming the results of experiments, reflecting about what the results might mean, and—perhaps most important—communicating with others.

The order in which these activities are performed is largely up to the scientist. No cookbooks. No algorithms of logic. Just equipment, a blank field journal, some self-discipline, a healthy dose of creative curiosity, and a desire to learn about nature for what it is—not for what we might wish it to be. This is the scientific spirit.

FOR YOUR INFORMATION

The success of science has much to do with an attitude common to scientists. This attitude is one of inquiry and honest experimentation guided by a confidence that all-natural phenomena can be explained.



Λ Figure 1.2

This diagram illustrates essential activities conducted by scientists. Commonly, the first activity is the asking of a broad question that defines the scope of the research. It is usually based upon the scientist's particular interests. The scientist can then move among all the various activities in unique paths and repeat activities as often as necessary.