WHAT IS SCIENCE?

[There is a] rhythm and pattern between the phenomena of nature which is not apparent to the eye, but only to the eye of analysis; and it is these rhythms and patterns which we call Physical Law.

R.P. Feynman
The Character of the Physical Law

Undoubtedly one of the most impressive discoveries made by scientists over the eons of human history on this planet is scientific inquiry itself. The beginnings of scientific inquiry marked a critical era as profound as the appearance of the first written language. Surprisingly, modern methods of doing science were not generally accepted by humankind until the late 16th and early 17th centuries. Thus in terms of human history, science is in its infancy.

A scientist seeks to understand how and why nature works. But scientists are far more successful in understanding the "hows" than the "whys". We are good at recognizing patterns in nature and predicting them. But our understanding of the complexities of nature has just begun. Although we would always like to know why some phenomenon occurs in nature, extracting this information can be very difficult. On the other hand, discovering how nature works through patterns revealed in scientific experiments can lead to general laws from which predictions about the phenomenon in question can be made. It is important to understand at the outset that science does not require an answer to the question of why something happens, only *how.*

A scientific *law* is a rule or a set of rules that generalizes the behavior of some phenomenon in nature. A scientific law once formulated and tested by experiments can be used to predict phenomena. A *theory* not only provides an accurate set of rules that can predict phenomena, but a theory can also sometimes explain the *cause* of the phenomenon. Thus a theory can be more powerful than a scientific law. However, neither a law nor a theory needs to specify a cause of phenomena in nature to be considered successful. Rather to become acceptable to the community of scientists as scientific laws and theories whether in the form of statements or algebraic expressions, the laws and theories must merely be capable of reliable predictions of natural phenomena.

In the physical sciences research is a process that improves our understanding of nature through revisions of the scientific laws and theories and by building the body of knowledge encompassed by the disciplines called the physical sciences. There is no exact way or recipe that tells us how science research should be done. We have general techniques that usually begin with questions raised while observing some natural phenomenon. If there is no known answer to the question posed, then a scientific experiment must be done to answer the question. Therefore *science begins with a question for which there is no known answer.* Once a question is posed, a scientist next creates a list of plausible hypotheses that might answer the question raised. In order to plan an experiment to test a plausible hypothesis, a scientist makes predictions that, assuming the hypothesis to be true, would be observable. Key to designing successful experiments is the

identification of all *variables* relevant to both the observed phenomenon and the question posed. A *controlled experiment* is one in which all variables but one can be controlled by the experimenter.

Next a *model* is proposed to explain the data collected in the experiment. The model might be based on known scientific laws and theories, and can be *physical, conceptual, analytical or pictorial.* The *proposed model* is compared carefully with the experimental data to check the model's validity. The model may need to be modified or the experiment altered many times before an acceptable match of the model with the actual phenomenon is achieved.

Physical science pertains to the study of natural phenomena associated with non-living objects. Physical science encompasses all sciences except the life sciences, and includes astronomy, chemistry, geology and physics. In the physical sciences we study the properties of matter and the interactions among non-living objects. Here we will not distinguish among the different kinds of physical sciences since the scientific laws and theories apply to all. The laws and theories created by scientists during the past 300 years weave the fabric of physical science that applies to all phenomena in nature.

Scientists have found that nature has an inherent, elegant order. The objective in doing science is to piece together nature's innate order. Science advances in a very piecemeal fashion, with parts of the fabric discovered through painstaking, deliberate and careful scientific research. Only very rarely is a huge segment of the fabric of science discovered which revolutionizes and reshapes all of science. The impact and importance of a colossal discovery are so large, that the scientific community is forever changed. In fact, the beginnings of modern physical science are marked with such a stunning advance that solved an immense problem that had loomed unresolved for centuries. The first huge segment of the fabric of science was produced by the laws of motion and the theory of gravitation discovered by Galileo and Newton in the seventeenth century. Modern science began with two profoundly fundamental questions posed by both Newton and Galileo: 1) What happens when an object falls to the ground? 2) What causes an object to fall to the ground?

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