

Introduction

**Science
is
Fascinating!**

Science is fascinating for anybody who values knowledge, because it is a body of knowledge as well as a method to acquire more knowledge. Indeed the word science is derived from the Latin word *scire*, meaning, “to know”. Science is dynamic, which means it is constantly developing, the science today is not exactly the same as it was, say, fifty years ago. This is so because scientists are always on the look out for new knowledge.

To gather new knowledge, scientists have to constantly ask questions, starting with What, Why, When, Where and How. You must be curious too, all children of your age are. But in science there is a particular way to answer such questions.

As you proceed through the answers provided in this book, you will discover that certain words like energy, force, cells, charge, etc. are used very frequently. Such words are the concepts of science. A concept is an abstract, universal idea, notion, or entity that serves to designate a category or class of entities, events, or relations. For example, God is a concept, so is length or height. Concepts like substances, animals, plants, food, electricity, information, communication, sky, universe etc. make science

possible and indeed this book is divided into sections dealing with questions related to these concepts.

Concepts help us to explain phenomenon. It may be a strange word, for most of the readers of this book, but it is important to know its meaning because it is central to all science and technology. A phenomenon (plural: phenomena) is an observable event. Phenomena constitute the world as we experience it, as opposed to the world as it exists independently of our experiences. Phenomena make up the raw data of science. It was an attempt to explain phenomena like seasons, earthquakes, lightning, rain, fire, sunrise, thunderstorm, rusting, blooming of plants, similarities between parent and offspring (heredity) etc. that lead to the development of science.

How do we know that what we see, hear or sense is a phenomenon? We say it is a phenomenon if it can be observed by almost everybody. The word observation is familiar to most science students. Textbooks and teachers of science often use it. Observation is an activity of an intelligent living being, to sense and assimilate the knowledge of a phenomenon in its framework of previous knowledge and ideas. Seeing, listening and feeling the happenings around carefully is observing. In science observation is an important activity, because science attempts to explain observations made by people.

To gather new knowledge, scientists follow a certain method known as the scientific method. Most of the common observations and phenomena can indeed be satisfactorily explained by using the known concepts, theories, hypothesis and laws of science.

You must be aware of Newton's law of gravitation, and perhaps, the law of conservation of energy or law of constant proportions. What is



common between these laws? Are they any different from the civil laws and criminal laws?

A scientific explanation does not use a motivating agent, such as God, most often it is through a mathematical relationship between several observable quantities. A law in science summarizes observed experimental facts—it does not explain the facts. Scientific laws are built on concepts, hypotheses, and experiments. They are as trustworthy as the concepts of science and as complete and accurate as the experiments on which they are based. Since human beings formulate scientific laws, they are neither eternally true nor unchangeable, like the divine laws. In fact with the advance of knowledge and experience, many laws of science prove, sooner or later, to be too limited or too inaccurate. An example is the law of conservation of mass, which today we recognize as having only limited applicability.

Thus, to explain any observation or phenomena, scientists take recourse to the known laws of science, or hypothesis and theories. In most cases, observations extend what is currently accepted, providing further evidence that existing ideas are correct. For example, in 1676 the English physicist Robert Hooke discovered that elastic objects, such as metal springs, stretch in proportion to the force that acts on them. Despite all the advances that have been made in physics since 1676, this simple law still holds true. But, this need not be always true. Sometimes, an observation or a phenomena cannot be explained by either existing laws of science, or any known theories. In such a case scientists advance new theories. If a theory is found useful to explain all such observations in general, it becomes a law.

Thus, the constant pursuit of knowledge to discover new laws or substances, is science. Science is a true adventure, that's why it is so fascinating. We hope you will pursue it further!

How does one become a scientist?

A scientist is a person who is aware of the many phenomena that occur in nature. S/he also understands the various concepts that are used to explain natural phenomena. S/he makes observations and tries to find if the existing concepts are adequate to explain them. Many people believe that anybody with a university degree in science can be called a scientist. But that is strictly not true. A scientist is a person who is curious to know the answers to questions, knows what answer are fit to be called scientific; for doing so s/he may need to carry out experiments, the results of experiments may warrant him to put forward a hypothesis, which may require discussions with other scientists or publishing papers in science journals.



A person who has earned a university degree in science can be expected to have a fair amount of knowledge about the existing concepts, laws, hypothesis or theories that have been put forward by scientists past and present, for example, your science teacher. But such people cannot be really called scientists. A true scientist is one who tries to add to this knowledge and not just earn a living using this knowledge.



What is energy?

Energy is not a solid, liquid or even a gas, but it can go from anywhere to anywhere. In fact it is everywhere. We cannot make energy, rather energy made us possible. Energy is a fundamental concept pertaining to the ability for action. In physics, it is something that every physical system possesses.

Energy of an object can be in several forms: potential—due to the position of the object relative to other objects; kinetic—energy because of its motion; chemical—due to chemical bonds between atoms that make up the substance; electrical—due to its charge; thermal—due to its heat; and nuclear—due to the instability of the nuclei of its atoms. Where the “object” is an **electromagnetic wave** or **light**, radiant energy can also be defined.

One form of energy can be readily transformed into another. For instance, a battery converts chemical energy into electrical energy, which can be converted into thermal (heat) energy. Similarly, potential energy is converted into kinetic energy of moving water and turbine in a dam, which in turn is transformed into electric energy by a generator. The law of conservation of energy states that in a closed system the total amount of energy, corresponding to the sum of a system’s constituent energy components, remains constant. This fact is known as the **law** of conservation of energy.



Professor Richard Feynman, the famous American Nobel laureate in physics, has said in his famous *Lectures in Physics*: “There is a fact, or if you wish, a law, governing natural phenomena that are known to date. There is no known exception to this law — it is exact so far we know. The law is called conservation of energy [it states that there is a certain quantity, which we call energy that does not change in manifold changes which nature undergoes]. That is a most abstract idea, because it is a mathematical principle; it says that there is a numerical quantity that does not change when something happens. It is not a description of a mechanism, or anything concrete; it is just a strange fact that we can calculate some number, and when we finish watching nature go through her tricks and calculate the number again, it is the same.”

What is matter?

Matter is the substance of which all physical objects are composed. It constitutes the observable Universe. According to the Theory of Relativity, there is no distinction between matter and energy, because matter can be converted to energy, and vice versa. Philosophically, matter constitutes the formless substratum of all things, which exists only potentially and from which reality is produced. In the sense of content, matter is also used in contrast to form.



Matter occupies space and has mass. It is composed predominantly of atoms, which consist of protons, neutrons, and electrons. It also includes subatomic particles, that is, particles said to constitute protons and neutrons, e.g. quarks and leptons.

What is a discovery?

A discovery is a new increment to our knowledge about nature. It can be an object not known earlier, a process or a phenomenon occurring in nature or understanding the structure of logical relationships between the known objects, processes or phenomenon. For example, a great astronomer Galileo Galilee discovered that it is the Earth that revolves around the Sun contrary to popular opinion at that time. Several decades ago two scientists James D. Watson and Francis Crick discovered that the structure of DNA molecules present in all biological cells is a double helix. The observable natural phenomena consist of all physical, biological, and social processes



that can be directly or indirectly observed. Logical relationships, on the other hand, are described by the study of pure logic, mathematics, statistics and computer science.

Objects occurring in nature are discovered too. Thus, if you find an animal, insect or bird or a planet or star that nobody knew before, you have made a discovery.



What is the Nobel Prize?

The Nobel Prize is the world's most famous and highest honour a scientist can aspire for. A Swedish inventor named Alfred Nobel instituted this prize in 1896. Though Nobel is also famous for inventing dynamite, he is remembered as a man who loved peace. Before his death (also in 1896), Nobel asked that these prizes be awarded to people who benefited humanity in some way. The Nobel Prize is the first international award given yearly since 1901 for achievements in physics, chemistry, medicine, literature and peace. The prize consists of a medal, a personal diploma, and a prize amount. A private institution, Nobel Foundation, established in 1900 based on the will of Alfred Nobel manages the assets made available through the will for awarding the Nobel Prize. It represents the Nobel institutions externally and administers informational activities and arrangements surrounding the presentation of the Nobel Prize. The Foundation also administers Nobel symposia in the different prize areas. The Indian scientist who has been honoured with the Nobel Prize is C.V. Raman. In addition two other natives of India who emigrated to USA and became US citizens and are therefore Americans have also been honoured with this prize; they are S Chandrasekhar and Hargobind Khorana.

