

Meaning of Science:

The English word Science is derived from a Latin Verb 'Scire', which means 'to know' and Latin Noun 'Scientia' which means 'knowledge'. Meaning of Science is based on German word 'Wissenschaft', which means systematic, organized knowledge. Thus, Science is a systematized knowledge.

The necessity and curiosity of man to know about himself and his surroundings has led him to investigate, find and to know about living beings and nature, which to verifiable knowledge of facts. But Science is not always about the collection of facts or development of new concepts or ideas. It is all about the passion for the discovery that drives one to explore the environment and the nature in every aspect.

Science is basically founded to investigate the nature and its processes. Although there are a number of other methods that can be utilized to acquire the knowledge about nature, but science is considered as the only one that results in the acquisition of reliable knowledge. Hence, Rene Descartes said, "Science is a method of investigating nature that discovers reliable knowledge about it."

Science is the investigation of unknown phenomena, and it also looks and compares with existing principles, theories and practices. Science is both a particular kind of activity and also the result of that activity. Science uses tools like observation, measurement and scientific experimentation and is entirely based on the observable facts.

Science is observation, identification, description, experimentation, investigation and theoretical explanation of the phenomenon that occur in nature.

Science could be described as the study, which attempts to perceive and understand the nature of the universe both living and non-living in its part and as a whole.

Definitions of Science:

During early times people perceived Science, as what the scientist does. There are many definitions available, though not a single definition could be universally accepted.

Some of the definitions are mentioned here to understand it from different angles:

1. According to Columbian Dictionary:

"Science is an accumulated and systematized learning in general usage restricted to natural phenomenon".

2. Einstein (1879-1955): "Science is an attempt to make the chaotic diversity of our sense experience corresponds to logically uniform system of thought".

3. Fitzpatrick (1960):

“Science is a cumulative and endless series of empirical observations, which results in the formation of concepts and theories, with both concepts and theories being subject to modification in the light of further empirical observations. Science is both a body of knowledge and the process of acquiring it”.

4. Bronowski, J. (1956):

“Science as the organization of our knowledge in such a way that it commands or makes possible the explanation of more of the hidden potentialities found in the environment”.

5. Conant (1957):

“An interconnected series of concepts and conceptual schemes that have developed as a result of experimentation and observation and are fruitful of further experimentation and observation”.

6. Fisher (1975):

“Science is the body of Knowledge obtained by methods, based upon observation”.

The above definitions clearly reveal that Science is both a process and product. A comprehensive definition of Science would be “science is a systematized knowledge gained through human observation and experimentation of cause revealing the unknown phenomenon of nature and universe both living and non-living involving the process of critical, creative thinking and investigation including sometimes sudden insights too.”

Science = Process + Product

= Methods + Knowledge

= Scientific Method + Scientific Attitude + Scientific Knowledge

Scope of Science:

Science is a body of knowledge obtained by methods based upon observation. Observation is authentic and that it is only through the senses of man that observations can be made. Thus, anything outside the limits of man’s senses is outside the limits of science. In other words, science deals with the universe and galaxies in the forms of matter and energy which is in the form of living and non-living.

Science employs several instruments to extend man’s senses to the extremely minute to very vast, to the short-time duration or long-time duration, to dilute or to concentrate and so on and so forth which does not alter the conclusion that science is limited to that which is observable.

Thus, as in any other discipline contemporary experimental techniques set up some practical limitations but these are not to be confused with the intrinsic limitations inherent in the very nature of science. The knowledge of science is tested and retested and reinvented.

Today the disciplines of Science and Social Sciences are drawing into each other. Behavioural zoologists study the sociology and psychology of animals. Archaeologists derive new insights from the rapid advances in chemical and physical analysis. Hence sciences should be understood with interdisciplinary approach within science. Biology draws on chemistry, physics, and geology.

Nature of Science

Human by birth has quest for knowledge as they are curious of knowing about nature. They have a highly developed brain because of which they can observe precisely, correlate observations and predict future happenings based on their observation. This ability helped humans to adjust to nature. The process of observing, describing, exploring, and using the physical world is science.

Science has certain characteristics which distinguish it from other spheres of human endeavour.

These characteristics define the nature of science as discussed below:

Science is a Particular way of Looking at Nature:

1. Science is a way of learning about what the nature is, how the nature behaves and how the nature got to be the way it is.
2. Science focuses exclusively on the nature.
3. It is not simply a collection of facts; rather it is a path to understand the phenomenon underlying.
 - (i) Science is, just the nature existing around you.
 - (ii) Every day we look at the rising sun and pay great respect to it for bestowing the earth with its light in energy form.
 - (iii) The knowledge of all that is in the universe from the tiniest subatomic particles in an atom to universe and galaxies.

Science as a Rapidly Expanding Body of Knowledge:

1. Science is the dynamic, ever-expanding knowledge, covering every new domain of experiences.
2. Knowledge refers to the product of science, such as the concepts and explanations.

3. Research being carried out in the field of science resulted in developing more knowledge at a faster pace sometimes by replacing old concepts, ideas or principles.

The technological developments that took place in recent times enhanced the acceleration of knowledge.

Science as an Interdisciplinary Area of Learning:

1. In the last two decades there have been studies claiming that science is becoming even more an interdisciplinary area of learning.

2. Science cannot be taught in isolation. All the branches of science are interdependent upon all other and there are a number of facts and principles which are common to various science subjects.

3. Knowledge started expanding day by day; scientists started specialising in certain areas. Hence the knowledge has been organized for convenience into different disciplines.

Environmental science is an interdisciplinary academic field that integrates physics, biological and information sciences (including ecology, biology, physics, chemistry, zoology, mineralogy, oceanology, limnology, soil science, geology of atmospheric science and geodesy).

Science as a Truly International Enterprise:

1. International collaboration in most of the projects is the order of the day.

2. In collaborative research, visibility among the peer and active exploitation of complementary capabilities increase.

3. Share the costs of the projects that are large in scale and scope.

4. Able to access expensive physical resources.

5. Exchange ideas to encourage greater creativity.

The large Hadron collider; at the European Organization for Nuclear Research (CERN) has been build up by scientists drawn from many countries including India. The experiment on this machine is being conducted by scientists from many countries including many Indian scientists. In this sense, science do not belong to any single country, or a group of countries and it would be morally and ethically wrong to deny the fruits of scientific development to any country in the world.

Science as Always Tentative:

Scientific models are always being questioned. Up-and-coming scientists always find gaps or errors in existing scientific models and develop a new one in place of them. In scientific field models have been tested and refined to such an extent that errors are likely to be minor. The real evidence needs to be scrutinized carefully.

Marine researchers have expressed concern about the effect of global warming on the future of coral reefs because increasing sea temperature cause coral bleaching. Bleaching happens; the corals expel the algae that live within their cells die when temperature rises. Recent research has tentatively showed that some algae may be able to adapt to temperature rises, consequently improved the chances that corals can survive.

Tentative Nature of Scientific Theories:

1. Scientific theories took decades in their development.
2. When two competing theories explain their observations related to a certain phenomenon, Scientists prefer to accept a theory which explains larger number of observations with few assumptions.

There was a time when both the geocentric and the heliocentric theories explained all the planetary observations. However geocentric theory had to introduce a new assumption every time. On the other hand, the heliocentric theory with just one assumption that all the planets revolve round the sun, it explained every available observation and eventually survived.

The fact remains that scientific theories are tentative and are always subject to change.

Science Promotes Skepticism:

“In science, keeping an open mind is a virtue just not so open that your brains fall out”-James Oberg.

1. Skepticism does not mean doubting the validity of everything, rather to judge the validity of a claim based on objective empirical evidence.
2. David Hume, the 18th century philosopher viewed that we should accept nothing as true unless the evidence available makes the non-existence of the thing more miraculous than its existence.
3. We examine the available evidence before reaching a decision until sufficient evidences are found.

Scientists are Highly Skeptic People:

‘Science is what scientists do’.

1. The scientists in different fields try to describe the phenomena in nature and establish their relationships.
2. After having described the phenomena, scientists attempt to find out the reason behind and make predictions.
3. Scientists use ideas of their own and of others as tools for testing and gaining knowledge. They use many resources to get valid answers to their questions and problems, by designing

their own experiments and invent new tools with which they observe and check different phenomena. Hence, scientists are highly skeptic people.

For instances, if we look at Newton's story the way he was inspired to formulate his theory of gravitation by watching the fall of an apple from a tree speaks his skeptic nature. Though many scientists and other common men were aware that all the objects descend perpendicularly to the ground, they never pondered upon it. This incident prompted Newton to explore the possibility of connecting gravity with the force that kept the moon on its orbit. This led him to the universal law of gravity.

Charles Goodyear (1800) a chemist and manufacturing engineer who developed vulcanized rubber. His discovery was accidental, where he explored the situation and after five years of searching for a more stable rubber and stumbling upon the effectiveness of heating.

Science Demands Perseverance from its Practitioners:

1. The important characteristic of science that brings development and progress is perseverance of scientists.
2. Scientists getting an inspirational idea, or a creative thought have to persist with the idea to take it to its logical conclusions, based on facts or observations.
3. Scientists may work alone or join with others in developing the idea further to find out ways to discover or invention, while at other times the scientists can make only a beginning and then others join them in developing the idea further.

The discovery of the wonder drug penicillin by Alexander Fleming in 1929 is the result of an incident happened by a chance which led to serious observation followed by hard work paved the way for discovery of many other antibiotics like Streptomycin and Erythromycin.

Science as an Approach to Investigate and as a Process of Constructing Knowledge:

1. The investigations in science involve some form of scientific method.
2. Scientists for seeking solution to a problem use different methods like observation, prediction and sometimes experimentation to study the cause-and-effect relationship.
3. Whatever we observe through our senses (information) is sent to the brain and the brain processes the information by registering, classifying, generalising etc., and converts into knowledge. Sensory perception is primary in knowledge development.
4. Here, the individual constructs the knowledge on his own by applying their own mental abilities and intelligence to process the information received through senses.
5. The basic unit of knowledge is fact. In science any repeatedly verifiable observation becomes a fact.
6. Scientific approach always is based on cause-and-effect relation.

Examples of facts are:

- i. Solids have definite shape and volume.
- ii. The rainbow is seen in a direction opposite to that of the sun.

Science and Social Environment:

Relating science education with the environment of a child has been the prime concern of educationists. The environment of the child includes natural and social environment.

In science we learn about the nature's phenomena. Human is a part of nature. Therefore, every effort should be made to integrate science with learning the environment. The science curriculum should address issues and concerns related to environment such as climate change, acid rain, growth of water, eutrophication, and various types of pollutions etc. Further, it should be applied to society to understand social phenomenon in a scientific way and solve all social problems with all objectivity and universal application.

Science teachers should aim to enlighten the young minds with the wonders of science. They should be engaged to construct the knowledge through an interdisciplinary approach appreciating its relation and impact on the social and natural environment. They can recognize the competence of science by doing activities related to their everyday life.

Current issues and events in science like new technological innovations, scientific discoveries, can be examined through social, economic, and ethical perspectives to help students in relating these issues with one another and explore their areas of interest.

The significance of chemistry to society can be highlighted by discussing the chemical components used in products that have altered agriculture, food, health, medicine, electronics, transportation, technology, and the natural environments. To understand its relevance to home economics, one can think what happens to the electricity bill if solar cooker, solar heater, solar lanterns and CFL (compact fluorescent lamp) are used.

For Instances- Bhopal Tragedy Unforgettable Industrial Disaster:

Industries are the symbols of development, but other side of the coin is lack of safety measures and irresponsibility of emitting pollutants. On 2nd December 1984 about 3000 human beings died and 5000 were effected seriously, thousands of cattle, birds, dogs, and cats died in just one night at Bhopal tragedy.

These mass deaths were due to the leakage of Methyle Isocyanate (MIC) into the air from an insecticide factory managed by union carbide. Thousands of lives helplessly crushed in this incident. This is unforgettable industrial disaster towards air pollution.

Essay # 6. Science and Technology:

Technology is often equated to applied sciences and its domain is generally thought to include mechanical, electrical, optical, electronic devices and instruments, the house hold and commercial gadgets, equipment used in physics, chemistry, biology, nuclear science etc. These various sub-domains of technology are interrelated. Modern technology is an applied science because the basic principles of sciences are applied to develop the technology.

Science and technology are linked to each other. Discoveries in science have paved the way for the evolution of new technologies. At the same time technology has been instrumental in the development of science.

Han's Christian Oersted, one of the leading scientists of the 19th century, played a crucial role in understanding electromagnetism. In 1820 he discovered that a compass needle got deflected when an electric current passed through a metallic wire placed nearby. Through this he showed that electricity and magnetism were related phenomena. His research later created technologies such as radio, television and fiber optics.

The development of microscope by Antony Van Leeuwenhock, where he intertwined optical principles with astronomical and biological understanding which further led to the development of the telescope.

Thus, science influences technology by providing knowledge and methodology. But on the other hand technology also influences science by providing equipments to find out the unknown phenomenon of the nature. This shows interdependence of science and technology.

In science we inquire how a natural phenomenon occurs, while in technology we deal with how the scientific processes can also be used for human welfare. Technology as a discipline has its own autonomy and should not be regarded as a mere extension of science.

Basically science is an open ended exploration; its end results are not fixed in advance. Technology on the other hand, is also an exploration but usually with a definite goal in mind. Science is universal; technology is goal oriented and often local specific.

People today are faced with an increasingly fast-changing world where the most important skills are flexibility in adapting to new demands and creativity in taking advantages of new opportunities. These imperatives have to be kept in mind in shaping science education.



Science and Society:

The applications of science and technology have led to the remarkable improvement in the quality of human life. It has given lot of comfort and leisure to the humankind on one side and

equipped it with skills needed for problem solving and decision making on the other side. It has changed the outlook of the individual on different beliefs, myths, taboos, and superstitions. People started working with logical thinking, objectivity, and open mindedness. Modern society believed in the co-existence of diversity in social and political thinking. Science always works for the welfare of our future generations by talking about sustainable development. Society is also showing its concern using the scientific knowledge for peace and prosperity of the society.

For instances, consuming tobacco (Gutkha, cigarettes, beedi, khaini) damages the internal organs of the body. The numbers of addicted people at the age of 15 or below are 57.57 lakhs (68%) both in Telengana and Andhra. When they reach 30 yrs. of age thin internal organs becomes damaged, this may lead to several problems and sometimes lead to death.

It is a dangerous trend in our country. So, we have to inculcate healthy habits in children by teaching science. Many youth are also addicted to alcohol which damages the liver and other body organs which in turn also affects human resource development.

Let Us Think It Over:

Do you know that our eyes can live even after our death? By donating our eyes after we die, we can give sight to a blind person.

About 35 million people in the developing world are blind and most of them can be cured. About 4.5 million people are with corneal blindness, can be cured by corneal transplantation of donated eyes. Out of these 4.5 million, 60% are children below the age of 12 yrs. So, if we got the gift of vision, let us pass it on to somebody who does not have it.

Importance of Science

The civilizations of the world have progressed to a higher rank due to the benefits of science. Science has contributed in endless ways to make our daily life comfortable and easy. Today's world knows about the importance of Green Chemistry, and the importance of Geology. We do not have to stay in darkness at the night. This has been possible because of the invention of bulbs and electricity. The few benefits of science in different fields are listed below:

- **Transportation:** Science has developed, invented, and discovered different mediums of swift communication such as trains, motor vehicles, boats or aircraft,

etc., that are very useful for us in our everyday life. Human beings have conquered Time and distance. We can explore the world in a shorter time through various modes of transportation. Transportation of goods has been made easy. The automobile and transport industry has grown tremendously due to developments in science and technology.

- **Communication:** Science has invented wonders in the field of communication and has transformed human life. The telephone, internet, E-mail, VSATs, networking, fax, cell phones, laptops, GPS systems, wireless, and telegrams are all the inventions of science that have brought the world closer to us. We can send news from one corner of the world to another within a single moment. The world wide web has been a boon to us, from which we can retrieve information by various means.
- **Medicine:** Advances in the biomedical field have led to fewer infections or lethal diseases than ever before. Physicians nowadays are more positive in their ability to cure or control them because of new inventions. Medicine has made large health advancements by supplying facts and care for different chronic conditions. Technology has enabled us to access these therapies via large devices and methods such as pacemakers, MRI machines, X-rays, ECG, operating systems, etc.
- **Agriculture:** Science has made the farmer's life easier and faster in many ways like sowing seeds, harvesting, spraying fertilisers, irrigation, etc., by improved machines. Farmers and scientists have used plant selection and breeding techniques to improve crop yield and quality. A better variety of seeds are used to enhance crop production.
- **Construction:** Advancements in science have made construction sites safer and workers more efficient and has allowed us to increase productivity, improve collaboration, and tackle more complex projects with the help of machines such as bulldozers, backhoe loaders, motor graders, etc.

Abuses of Science

Science has many advantages that can help humans in various fields and sectors. In the same way, science has many disadvantages or abuses caused by the over usage of science and its technology.

- Air pollution is caused due to usage of vehicles.

- Science has led to the development of deadly weapons that could wipe out humanity easily.
- The nuclear bomb, explosives, hydrogen bomb, poisonous gas, missiles, chemical warfare, etc., can put the entire city out of existence.
- The usage of chemical fertilisers on a large scale can decrease the soil quality and affect the quality of food.
- Dumping of industrial wastes in water sources like rivers, oceans, etc., creates havoc on aquatic life forms.
- Advancement in science also led to the misuse of mass media for propaganda.

Summary:

Science and applied science-based technologies have transformed modern life. They have led to dominant improvements in living standards, health, public welfare, and security. They have changed how we think about ourselves and how we view the universe in relation to the world around us. Biological development is one of the most necessary ideas of advanced science. Evolution is maintained by sufficient evidence from various fields of scientific investigation. It is a chief modern biological science, including the biomedical sciences, and has applications in many other scientific and engineering disciplines.

Science and Society

Science generates solutions for everyday life and helps us to answer the great mysteries of the universe. In other words, science is one of the most important channels of knowledge. It has a specific role, as well as a variety of functions for the benefit of our society: creating new knowledge, improving education, and increasing the quality of our lives.

Science must respond to societal needs and global challenges. Public understanding and engagement with science, and citizen participation including through the popularization of science are essential to equip citizens to make informed personal and professional choices. Governments need to make decisions based on quality scientific information on issues such as health and agriculture, and parliaments need to legislate on societal issues which necessitate the latest scientific knowledge. National governments need to understand the science behind major global challenges such as climate change, ocean health, biodiversity loss and freshwater security.

To face sustainable development challenges, governments and citizens alike must understand the language of science and must become scientifically literate. On the other hand, scientists must understand the problems policy-makers face and endeavour to make the results of their research relevant and comprehensible to society.

Challenges today cut across the traditional boundaries of disciplines and stretch across the lifecycle of innovation -- from research to knowledge development and its application. Science, technology, and innovation must drive our pursuit of more equitable and sustainable development.

