Definitions of Science:

What comes to your mind when the word 'science' is mentioned? Is it chemistry, physics, biology or mathematics? The word 'science' is derived from the Latin word, 'scientia' which means 'Knowledge'(Eneh: 2000).

On the simplest level, science has been defined as the knowledge of the world of nature.

The above definition however does not exhaust the full meaning of science.

Science as a body of knowledge What does the word 'body' tell you? The bodies of knowledge generally regarded as science include, chemistry, biology, physics, mathematics, microbiology, pharmacy and medicine.

Science as a method for acquiring knowledge Science has well-known procedures for obtaining knowledge.

The two branches of science, which are empirical and formal sciences, use what is called the scientific method.

Formal science utilises concepts, rules and theories, and expresses them in quantitative and statistical manner.

Science as an institution:

Science can be viewed as an institution which comprises millions of experts. These experts engage in the study and development of human knowledge.

Branches of science:

1. Formal sciences
2. Empirical sciences

Formal sciences include mathematics (which comprise geometry, algebra, trigonometry, arithmetic), logic, theoretical physics, and statistics. Formal sciences have a formal and deductive character.

Science is said to be formal if its contents, arguments and procedures obey certain rules.

Empirical sciences, on the other hand, include physics, chemistry, biology, psychology, botany, zoology, biochemistry, microbiology, geology, medical sciences, etc. These study objects and phenomena which can be observed through any of the senses and which can be tested with instruments such as the telescope, microscope, ruler, tapes and scales. In other words, anything that cannot observed with the senses of sight, touch, hearing, taste and smell or with instruments such as ruler, telescope, etc. is outside science.

Scientific Method of Acquiring Knowledge:

Superficially, science is a collection of 'facts' (body of knowledge) that describe and explain the workings of nature. Although these facts are interesting - even fascinating - they are not the essence of science. Rather, the excitement of science lies in the intriguing observation and the carefully designed experiments that scientists have devised to help us learn about nature.

What is law of nature?

Some people believe that some regularities are figments of human imagination.

They say that the human mind leaps to conclusions because it cannot tolerate disorder or chaos.

Thus it constructs regularities even when none objectively exists.

These true regularities must be established by an impartial or unemotional examination of data.

Science also insists on getting explanations of the causes of these regularities.

Attributing some causes to spiritual and divine forces is not permissible in science.

Since scientists believe that the world is comprehensible, that is, understandable because there is order in the world, finding the causes of these regularities wouldn't be problematic.

If you can take your mind back to unit 3, you will remember that 'an explanation about the cause or causes of a broad range of related phenomena' was called a theory.

Examples of laws of nature are:

1. Law of the uniformity of nature
2. Law of causation
3. The law of gravitation
4. The law of natural selection

Belief in the uniformity of nature:

There is a general belief that the universe and all aspects of it are lawgoverned and that the ordinary events or procedures of nature are uniform.

The birth of children, death, growth, normal and abnormal occurrences,

lightning and thunder, the seasons, day and night, etc: these phenomena are usually explained in terms of general rules or causal laws.

In traditional thought, these laws are believed to have a spiritual and teleological character.

Teleology is a view that developments occur because of the purpose or design they serve.

Traditional people look for the purpose for the occurrence of any event.

If a tree breaks or a house suddenly collapses, traditional mind will seek to explain such a happening in terms of the purpose, interest and wishes of some spiritual forces.

Thus, the principles, laws or factors, which the traditional mind uses to explain the work of natureis often speculative, that is, meditational in character.

Therefore the laws or factors may be superstitious and unreliable.

The scientist explains the work of nature in terms of material, causal and

rational factors.

This knowledge is expressed in terms of general rules or laws.

Therefore according to J.S. Mill cited in Nwala, it is the custom in science, wherever regularity of any kind can be traced, to call the general statement which reveals the nature of that regularity a law.

Science establishes such laws through the steps of the scientific method.

You know that the steps include observation, problem definition, hypothesis formulation, experimentation, conclusion and, finally, an appropriate theory is formulated which embodies the law.

This view is called the law of the uniformity of nature.

The study of nature is the study of these laws and uniformities, which different natural phenomena show or exhibit.

The scientific revolution:

This was a period that witnessed a complex change in scientific outlook. It started in the late 15th century, and reached its highest point in the 16th and 17th centuries. True experimental science, free from philosophy and religion, emerged in the 16th and 17th centuries. The first great change in scientific outlook after the renaissance was made by a polish mathematician and an astronomer called Nicolaus Copernicus (1473 - 1543) (Damper: 1989).

What Galileo and Kepler could not provide, although they tried quite hard, were answers to these questions:

i. If the earth revolves on its axis round the sun, then why do objects not fly off it?

ii. How is it possible for the earth suspended in empty space to go round the sun - whether in circles or ellipses - without anything pushing it? The answers were long in coming (The ew Encyclopaedia Britannica: 1995).

The year 1660 seems to be the most important time in early development of modern science.

Physical sciences:

Some discoveries in physics, which really led to a true revolution are worthy considering here.

X-rays, as you know are used in hospitals to destroy cancerous cells, to

look at bones, to check if they are broken or dislocated, especially after an accident.

In industries, x-ray photographs are used to reveal hidden cracks in metal castings and welded joints.

X-rays are also used to detect alterations, which have been made to art works.

The discover y of x-rays and radioactivity revealed to the physicists that the structure of the atom was not as simple as they thought.

There were other components of the atom, which they didn't know about such as electrons and protons.

Thus, definition of the atom 'as the indivisible particle of matter' had to change.

The most disturbing of all the upsetting results of early 20th century physics was the formulation of Theory of Relativity by Albert Einstein in 1905.

The theory redefined physics, thus making classical Newtonian physics obsolete.

According to Newtonian physics, time, space, motion, etc were objective properties; that is to say, they exist on their own.

That is the first basic part of Einstein's theory.

The second basic part of his theory said that the only absolute unchanging quantity in the universe was the speed of light.

Because of this theory, the very foundations of physics threatened to crumble.

In spite of all these, it may interest you to know that science in the 20th century worked wonders.

The new physics - relativity, quantum mechanics, particle physics - may insult our common sense but it enables physicists to examine closely the minutest part of matter.

It may specially interest chemistry students to know that chemists of the 20th century used the new information about atoms reported by the physicists to improve their idea about chemical bonds.

It is good for you to know that all the plastic cups, plates basins, slippers etc which were use in our homes, were produced by using the new information about atoms.

Polyester nylon stockings, shirts and dresses are practical things made from the new information about atoms.

It may also interest you to know that astronomy and cosmology have been transformed almost beyond recognition.

As a matter of fact, the first men to walk on the moon were American

Astronauts called Neil Armstrong and Edwin Aldrin. The first woman in space is Velentina Tereshkova, and that was in 1963.

Biotechnology:

Modern biotechnology is now recognized as one of the most developments of the 20th century.

Of the many uses of biotechnology are test tube babies, artificial insemination, gene cloning, animal cloning etc.

Biotechnology is not an academic discipline like Biology or Chemistry.

This means that many disciplines are involved in any biotechnological activity.

They include microbiology, biochemistry, genetics, plant and animal biology, chemical and process engineering.

Biotechnology is therefore defined as the techniques that make use of living organisms or parts of organisms such as cells, to make or products,

to improve plants and animals, or to develop microorganisms for specific applications.

The aim of using these techniques is to increase the production of goods and services for the benefit of mankind.

Some of the techniques of biotechnology are as follows:

Genetic engineering is the hard core of biotechnology.

That is the reason why many people mistakenly assume that biotechnology means genetic engineering.

The lost sciences of Africa:

Recently, archaeology has revealed the distinctive features of a lost African science, at least, in areas outside Egypt.

It is also only within recent years that the discovery of a rudimentary black kingdom in the Nile valley, predating the Egyptian dynasties, has settled the question, once and for all, of all roots of classical Egyptian

culture and technology.

These astonishing discoveries have shaken the whole world, including some Africans, who were not aware of the major contributions of blacks to modern technology.

Africans, just like the Europeans, or Asians, or Americans were characterised by the slow spread of new techniques or technologies from the centres to the edges, or peripheries of their civilisations.

It is necessary that you understand that this phenomenon of concentration of high technology in a centre and its absence or slow spread to the periphery was the same all over the world, before the industrial revolution.

If you use this statement to compare the present countries of the world, you would agree that the centres of high technology are concentrated in powerful industrial countries.

While at the edges would be found whole countries or continents with jus t fragments of that technology.

It is important to understand the above paragraph, if we are to understand

how science or technology may rise and fall with civilisation.

The destruction of a centre could lead to the almost instant evaporation or disappearance of centuries of knowledge and technical skills.

A nuclear war could destroy the primary centres of twentieth century echnology in a matter of days.

The survivors on the periphery they would remember the aeroplanes, the

television sets etc, they would not be able for centuries to reproduce that technology.

Centuries afterwards, the technological brilliance of the 20th century would seem dream-like and unreal.

The catastrophic effect has been the low technological know-how of Africans of today.

Another traumatic effect visited on Africa was the slave trade, which lasted for centuries.

Five centuries later, archaeologists, digging among the ruins, began to pick up some of the pieces.

Metallurgy:

In 1978, an anthropology professor called Peter Schmidt and a professor of engineering called Donald Avery, both of them lecturers at Brown University, in USA, announced that between 1,500 and 2,000 years ago, Africans who lived on the western shores of Lake Victoria, in Tanzania, had produced carbon steel. What is steel? It is a malleable mixture of iron and carbon elements. It is used in producing tools, weapons, etc. For example, the Ajaokuta steel complex in Kogi State of Nigeria is being built with the aim of supplying raw materials to the tool industries.

The impact of science and technology on society:

Where do you live? In a village or in a town? Wherever you may be living, you are likely to see, hear, and touch or use various objects in the course of a single day.

In addition to all these, you are likely to touch and use such devices designed to save physical labour such as tractors, those designed to help in communication, entertainment, transportation, high-speed computers and medicines.

All these and many more are called products of technology.

It is interesting to note that before each of these products developed, a significant scientific discovery had been made.

Each of these examples demonstrates a symbolic relationship between science and technology.

Knowledge obtained fromthe scientific disciplines of mathematics and electronics were used to produce highspeed computers.

What other connections can you make between science and technology? Has technology had any effect on your lifestyle? Consider how it has affected the way you eat, drink, travel, work, play and sleep.

Think about technology and environmental implications - how some of

the products such as cars can cause air pollution with the exhaust fumes.

Also think about technology and life and death - about how babies are born today and how old people live before they die, as compared to a hundred years ago.

You might now be aware that key influences in all these are science technology.

These have been the most potent forces for social change in the history of man.

Meaning of philosophy of science:

It may interest you to know that philosophy of science is a branch philosophy.

Common characteristics of philosophy and science:

1. They are both critical, skeptical and non - dogmatic in character or attitude. In module 1, unit 2, we explained what a critical attitude means.
2. They both show the curiosity to know and the courage to explore

every question within no-go areas and heresy.

3. They both search for knowledge which is rational, systematic, universal, objective, certain and verifiable (that is provable or demonstrable).

4. They both lay emphasis on method. The deductive method is important for philosophy while both the deductive and inductive methods are important for the sciences.

Various views on the origin of man:

The religious view:

The religious view is upheld by the creationists. Man, according to them, is created by God and in God's image. This view is also upheld by the African traditionalists.

God is variously called Allah, Chukwu, Olodumare, etc. The most popular accounts of the origin of man are found in the doctrines of various religions. For instance, the Christian account of man's origin can be found in chapters 1 and 2 of the Book of Genesis in the Holy Bible.

The scientific view

It may interest you to know that this view is held by the evolutionists - people who believe in the theory of evolution

Scientists in the field of paleontology, comparative anatomy, embryology, natural history, etc have provided evidence for this evolutionary account of the origin of man and other creatures from the study of fossils.

Origin of hominids

You may not be aware of what hominids are. Hominids constitute the zoological family to which human beings belong. The family has only a single surviving specie Homo sapiens. The first hominids emerged 5 million to 10 million years ago. That was during the Miocene period. Fossils of human-like forms discovered in Africa were about 4 million years old. Varieties of hominids were found but many had three features in common namely:

1. Pedalism - ability to stand on two legs
2. Omnivorous feeding behaviour
3. Brain expansion and elaboration.

These hominids possessed the ability to be flexible and had a wide range of demands.

For instance, the first hominids that appeared were able to use the

hands, survive on more than one type of food and had brains that enabled them learn how to adapt to the changing environment.

The earliest known hominids were members of the genus Australopithecus (meaning southern ape) and they survived for 3 million years. At least four distinct species were distinguishable: Australopithecus afarensis, A. africanus, A. boisei and A. robustus. These early humans were found only in Eastern and Southern Africa.

Australopithecus aferensis

This genus was found in 1978 at Hader in Ethiopia by Johanson, Yves Coppers and co. They were regarded by paleontologists as the stem stock leading to later Australopithecus and Homo sapiens. Their fossils exhibited a mixture of human and ape characteristics.

The skulls were ape-like -- small with large projecting faces.

Australopithecus africanus

This was discovered in 1924 in South Africa by Raymond Dart. This

fossil shared many anatomical features with those of A. aferensis.

A. africanus individuals were relatively small bipedal humans with protruding face, a slightly larger brain than that of A. aferensis. The body differed a little from that of the earliest hominids. Analysis of the hand and foot structure showed that these hominids spent time on trees probably while sleeping or feeding or perhaps for safety. The teeth looked more like those of human than ape in their sizes and shapes. The cheek teeth (molars and premolars) were flat for grinding and crushing and were set on heavily built jaws. These were probably for processing coarse abrasive food such as tubers.