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# **BENZOIC FAMILY**

Philosopher Kings of FUTO

# **GST 110**

**PHILOSOPHY OF SCIENCE  
SCIENCE, TECHNOLOGY AND SOCIETY**

*Meekness*

## **LECTURE NOTES & PAST QUESTIONS**

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## CHAPTER ONE

### MEANING AND PURPOSE OF SCIENCE

#### Etymology

Science as it is being used in English language today is a comparatively new word. It got its accepted meaning only in the early part of the 19<sup>th</sup> century. What we now call science was earlier labeled natural philosophy being only one of the branches of philosophy. The word science comes from the Latin verb 'scire' meaning "to know"- to have any form of organized knowledge. But the Latin 'scientia' (noun form of the verb scire) which is transliterated as science means true and certain knowledge based on intrinsic evidence.

#### Definition

A science is a body of related data set forth in an orderly manner which is marked by completeness and by the consistent manifestation of causes and which justifies each step of its development. Or simply put science is the orderly knowledge of things in their causes.

Science is the knowledge that is certain because it is evidenced by causes and reasons. In its full objective meaning science is the whole body of ascertained and reasoned truth and has been systematized and arranged.

Science is however generally regarded in the three main ways as follows:

1. Science is seen as a body of knowledge.
2. Science could be seen as a method for acquiring knowledge or studying and understanding the world.
3. Science is also seen as an institution comprising thousands or millions of experts engaged in the development of human knowledge in various research centers and educational institutions.

Science in its most primitive and original context is the acquisition of knowledge through methodical procedures and built into a coherent system. Scientific knowledge therefore means knowledge of facts or truths together with their explanations, their justification and their rationale.

The word 'scientist' was coined by an English philosopher and scientist named William Whewell in the year 1833 and was first published in 1834 in a quarterly review and later in 1840 in his work titled "the philosophy of



the inductive sciences".

### The aim or purpose of science

Knowledge according to Francis Bacon is power and if we acquire knowledge it will help us to improve our standard of living. The primary aim of science as such is to acquire knowledge. Science seeks to learn about the world of living and non living. In science we seek to explain how the world, event and objects around originated, how they function or operate. Thus we can say that science equips us with practical knowledge in terms of mechanism and instrumentalism.

But science does not rest satisfied with just learning about the world, it has another objective which is to modify the world as far as possible using its application to industry (technology). With technology man is able to achieve a lot.

### Six characteristics of science

1. **Consistency:** several scientists can repeat an experiment and the results are the same.
2. **Observability:** the result or subject of experiment of scientific experiment can be observed by using the five senses or extension of it.
- 5 2 3. **Natural:** a natural cause must be used to explain why or how the naturally occurring result or experiment subject happens. Supernatural cannot be used.
4. **Predictability:** predictions can be made about the subject and can be tested.
5. **Tentativeness:** scientific theories are subject to change because of change in technology.
6. **Testability:** subject can be tested using a controlled experiment.

Other characteristics of science include:

7. **Materiality:** the object of science is material.
8. **Specificity:** experimental science reduces our investigation of nature to a specific set up.
9. Conclusions of science are reliable and tentative.
10. Science is non-dogmatic.
11. Science cannot make moral or aesthetic decisions.



12. Science is not democratic but makes well defined claims based on the best available evidence.
13. Science demands the honest use of scientific methods and truthful reports.

### **Material object and formal object of science**

Material object of a science is the subject matter which the science treats or deals with. The formal object on the other hand can be defined as the approach or the perspective from which a science studies its material object. Formal object is the specific character that distinguishes it from other sciences in the same general field or among sciences that have the same material object. For example both philosophical anthropology and psychology has man as their material object but while anthropology studies man as a composite being made up of body and soul, psychology limits itself to the study of man's behavior.

All academic disciplines in a university or institution of learning could be said to be scientific since they are methodic, systematic with proper material and formal objects.

### **Important Definitions**

**An axiom:** or postulate is a statement that is so evident or well established that it is accepted without controversy or questions.

**Hypothesis:** is a proposed explanation or supposition (tentative guess) made on the basis of limited evidence as a starting point for further investigation. For a hypothesis to be a scientific hypothesis, the scientific method requires that one can test it.

**Theory:** is a coherent group of tested general propositions commonly regarded as correct that can be used as principles of explanation and prediction for a class of phenomena.

**Fact:** is something that has really occurred or is actually the case. The usual test for a statement of fact is verifiability- that is whether it can be demonstrated to correspond to experience. Scientific facts are verified by repeatable careful observation or measurement.

**Scientific Law:** is a statement based on repeated experimental observation that describes some aspects of the universe. A scientific law always applies under the same condition and implies that there is a casual relationship

involving its elements

### **Other Important Definitions**

In this section we shall briefly define a few selected terms that is associated with science and scientific propositions.

**Scientificity:** this can be simply defined as the quality or state of being scientific.

**Scientism:** this is the belief in the universal applicability of the scientific methods and approach and the view that empirical science constitutes the most authoritative and value-able part of human learning.

**Scientific realism:** this is a positive epistemic attitude towards the content of our best theories and models, recommending belief in both observable and unobservable aspects of the world described by science. In other words, scientific realism is the view that the world described by science is the real world, as it is independent of what it might be taken to be.

**Scientific reductionism:** this is the idea of reducing complex interactions and entities to the sum of their constituents' parts in order to make them easier to study.

**Scientific naturalism:** is a view according to which all objects and events are parts of nature. I.e they belong to the world of time and space. Therefore everything including the mental realm of human beings is subject to scientific inquiry.

**Scientific objectivity:** is a characteristic of scientific claims, methods and results. It expresses the idea that the claims, methods and results of science should not be influenced by particular perspective, personal interest or bias.

**Positivism:** is the view that the only authentic knowledge is scientific knowledge and that such knowledge can only come from positive affirmation of theories through strict scientific methods.

### **Scientific attitude**

1. Critical mindness
2. Respect for evidence
3. Honesty and humility
4. Objectivity



5. Willingness to change opinion and ability to accept defeat
6. Creativity and open mindedness
7. Curiosity or questioning attitude or inquisitiveness
8. Tolerance of uncertainty and perseverance
9. Skepticism

### **Divisions or classifications of science**

Science has 2 major divisions or classifications namely **Real (empirical) science** and **Formal science**.

**Real science:** Have within its purview, the Natural, Social and Cultural sciences. Real science bases its results on empirical justification and verification of facts. It takes up some definite aspect of the world of experience through the use of some definite methodology. Real science with emphasis on empirical justification comprises of natural sciences such as physics, chemistry, astronomy, theoretical medicine, biology, geology, petroleum engineering, polymer and textile etc. The cultural sciences comprises of history, religion, art and language while the social sciences are political science, sociology, economics etc.

**Formal science:** is comprised of formal logic which deals with mental processes or logical reasoning. Mathematical science as a type of formal science emphasizes pure forms or quantities and abstract structures and facts. The formal science does not go after sensory realities but achieve their results through logical reasoning. The formal sciences have a formal and deductive character. Other characteristics include: necessity, universality and certainty. Thus science is said to be formal if its contents, arguments and procedures obey abstract rules. Examples of formal science include theoretical physics, mathematics, statistics, logic etc.

### **Other classifications of science**

**Hard and soft science:** these are terms used to compare scientific fields on the basis of perceived methodology, rigor, exactitude and objectivity. While the natural sciences are considered 'hard', the social sciences are usually described as soft.

**Pure and applied science:** Pure science develops information to predict and perhaps explain-thus somehow understand phenomena in the natural world. Pure science is also defined as the quantitative and objective

knowledge of nature for its own sake without consideration for practical application. Applied science is a discipline of science that applies existing scientific knowledge to develop more practical applications like technology or inventions.

**Theoretical, Practical and Productive Science:** According to Aristotle, sciences may be practical, theoretical or productive science. Theoretical science seeks knowledge for its own sake (philosophy, metaphysics, mathematics) practical science concerns conduct and goodness in action individual and society (politics and ethics), while productive science aims at the creation of beautiful or useful objects (ship building, agriculture, medicine etc.).

## TECHNOLOGY

Technology was derived from the Greek words "Techné" and "logia". Techné means art, skill, cunning hand. Technology is the collection of techniques, skills, methods and processes used in the production of goods and services or in the accomplishment of objective such as scientific investigation. Technology can also be defined as the application of scientific knowledge and research with the aim of developing products and processes for the use of man.

### Advantages of technology

1. **Higher profit:** compared to manual labor, advancement in technology has made it possible to undertake complex routines in industries which have led to more increase in production and in turn higher profit.
2. **Fast access to information:** internet technology, telephone and GSM are powerful technological innovations that have improved enormously our access to information and communication.
3. **Speed up work:** technology has affected every sphere of human endeavor. In business technology has led to the development of computers and other devices that have helped to speed of work.
4. **Increase communication:** distance is no longer a barrier in terms of communication as a result of technological advancement. The internet, telephone and GSM communication has made it possible for one to send and receive messages from any part of the world at great speed.
5. **Cost efficiency:** machines are usually able to produce more output than human labor. Businesses are now able to cut down cost on labor by employing sophisticated machines that can cover for human labor.



6. Technology has led to great discoveries in all industries especially in showing people a more efficient way to do things which yields greater and faster results.

### **Disadvantages of technology**

1. **Dependency:** improvement in technology especially with the way most devices now make work easy has made some persons to rely so much on it that without it life would become meaningless.

2. **Less value on human workers:** advancement in technology leading to the manufacture of sophisticated devices made it possible for industries to replace human labor with machines. This places less value on human labor.

3. **Difficulty in integrating new technology:** another disadvantage associated with technology is the difficulty in integrating new technology. Some persons get so used to previous ways of doing things that they find it almost impossible to flow with a new system.

4. **Technology related diseases:** advancement in technology also comes with it a baggage of medical issues. Prolonged use of the computer and other related devices have adverse effects such as explosion to radiation, eye effects etc.

5. **Online fraud:** this is the use of the internet to defraud other people of their money and valuables. It is a serious crime punishable under the law in most countries.

### **Terms related to Technology**

**Techno-Philia:** refers generally to a strong enthusiasm for technology especially new technologies such as computers, the internet, mobile phones etc. the term is used to examine individual's interactions with society and is contrasted with technophobia.

**Techno-Phobia:** this is the opposite of technophilia. It refers to the fear or dislike of advanced technology or complex devices especially computers. The term is generally used in the sense of an irrational fear and is related to cyber phobia.

**Technocracy:** is an organizational structure or system of governance where decision makers are selected on the basis of technological knowledge.

**Techno-Science:** is a compound noun that refers to the entire longstanding global human activity of technology combined with the relatively recent scientific method that occurred primarily in Europe during the 17<sup>th</sup> and 18<sup>th</sup> centuries.



## CHAPTER TWO

### THE SCIENTIFIC METHODS

Method is an English form of the Greek "Methodos" which means "a way after". Method is therefore a way after truth, a reasonable and orderly procedure in attaining the truth and certitude. It is a proper mode of acquiring truth.

Science as we know has got various procedures and approaches. It should be understood therefore that within the matrix of scientific inquiry or methodology there are two major approaches. These two principal types of methods which are not opposed to each other but are supplementary are:

#### **Deductive Method and the Inductive Method**

##### **Deduction as a method**

Deductive method of reasoning attempts to establish a conclusive inference deduced from a general instance. In other words it is a process of reasoning in which we conclude from a general law or principle to a particular instance falling under the general law or principle. For example knowing that all mammals suckle their young, one would infer deductively that a rabbit will nourish its offspring by nourishing them. In deductive reasoning, when the premises of an argument are true, invariably the conclusions must be true. The deductive method is regarded as the hallmark of Logic. Deductive has the feature of being circular and tautological.

##### **Induction as a method**

Induction is the process in which we conclude from individual cases to the existence of general laws and principles. In the inductive method we proceed from the particular to the general, from the concrete to the abstract. The results of all inductive inferences are always probable; this is because it is based on sense experience of particular instances and since all of the instances have not been exhausted it becomes a problem to make a universal statement or assertion based on it. Induction is an often used scientific method. It utilizes sense experience which emphasizes observation, collection of data, experimentation and formulation of theories. Thus induction can be defined as reasoning in which the conclusion is believed to follow from the premise not with logical necessity but with probability. Francis Bacon the pioneer of scientific methods posits that every scientific investigation should begin with empirical facts. Bacon



believes in the inductive sciences and induction is regarded as the hallmark of science.

### **The five fundamental presuppositions of science**

Though the general method of reasoning employed by the natural science is that of induction, natural sciences rest upon certain fundamental presuppositions. Natural or experimental science cannot prove everything; it must take some things for granted. The five fundamental presuppositions which it must take for granted are:

1. The physical world truly exist
2. The physical world is knowable
3. Man has the power to obtain reliable knowledge of the world.
4. Nature is uniform
5. Everything in nature is caused by something. (the principle of causality)

### **Other Methods of Science**

#### **Observation**

Observation is a matter of sense perception. On the basis of our observation we draw conclusions regarding relations, casual sequences and the meaning of the situation. Some sciences such as astronomy and botany have been built by careful and methodical observation.

#### **The method of agreement**

This is one of the inductive methods. The principle involved is that the sole invariable circumstance accompanying a phenomenon is casually connected with the phenomenon. Accurate observation that may be verified by independent observers is crucial to scientific investigation.

#### **Trial and Error**

This method is also known as "Learning by Doing". It is quite universal and well known. It is used by animals as they try to solve problems. It is a technique studied as well as used by psychologists as they work with men and animals. It is used to see how gadgets work.

#### **Experimentation**

Active experimentation is the principal method of discovering and

verifying causes. Experimentation involves manipulation and control. In an experiment, the observer controls the conditions relating to the subject of his study, and then he manipulates these conditions, changing one factor at a time so that he may record results.

### **Concomitant variation method**

This method deals with the relationship between two phenomena that vary as a result of some common casual connection. It may be either observation or experimental. This method may show that two phenomena increases or decreases together or that one increases as the other decreases.

### **Statistical method**

This method has to do with the collection, analysis and classification of data which may serve as a basis for induction

### **The method of sampling**

This is the method in which we take the nature of certain membership. The method of sampling basically tries to see if a single instance is likely to be an accurate representative of the whole and when it not likely to be. When the material to be examined is known to be homogenous throughout, a single sample will give accurate results. But as the heterogeneity of the material increases, the number of samples taken must increase.

## **STEPS INVOLVED IN SCIENTIFIC RESEARCH**

The various methods of science are not separate and distinct; they are interrelated and supplement one another. In a general way we may say that scientific methods are collective term designating and denoting the numerous processes and steps by which the various sciences are built up. Thus the acquisition of scientific knowledge in a wider sense follows the following steps or methodology:

1. Problem identification
2. Formulation of hypothesis
3. Collection of data/experimentation
4. Analysis of data and theory formulation
5. Conclusion



### **1. Problem identification**

Every research is about a problem. It is the problem which necessitates the research and such problem could be in the form of some phenomena to be understood or an anomaly that needs rectification. Identification of research problems requires close observation in order to have a good understanding of the problem. When a problem is identified, one's energy is geared towards asking questions. To be of value to science, a question must be relevant and must be testable. This is done by formulation of a tentative guess to explain the phenomena.

### **2. Development of hypothesis**

This is the development or formulation of a tentative guess to guide the process of the research. One guesses what the answer to the question might be. Thus there are possibilities that a random guess will be wrong. The main function of a hypothesis is to predict new experiment or new observation. A hypothesis should be reasonable, should give rise to deductions that can be tested and should be a guide to further research.

But if a hypothesis is proven false, it will be discarded in favor of another hypothesis. One of the functions of the scientific enterprise is experiment to test the validity or truth content of a scientific guess or hypothesis. This can be made by experiments.

### **3. Collection of data/Experimentation**

The next major procedure in scientific investigation after a hypothesis is the experimentation stage. Experimentation is by far the hardest stage of the scientific method. In this stage the procedure is to find ways and means of tackling the problem. Such a plan will be realized in the selection of the most appropriate concepts, analytical paradigm, specific sampling techniques, instruments and tools of data collection.

It is experimentation that makes knowledge of science authentic through proof, test, demonstrations or illustrations. This stage is also seen as the moment of field work where relevant data or information is collected and taken to the laboratory for analysis in order to test the already stated hypothesis.

There are 3 major tools and techniques for collecting research data: the questionnaire, interview and observation. The issue of which tool to use at

any time depends essentially on the type of data one is looking for.

#### **4. Analysis of data and theory formulation**

Analysis proceeds from the data collected during the process of experimentation. Once there is a fault in data collection, it will invariably affect the analysis. Thus much attention is usually paid to the data collection type. If a hypothesis has been proven right it will be established as true. At this point the scientific investigator comes up with some sort of knowledge or key to uncovering another scientific knowledge. The scientific investigator with this new discovery might propose a theory to explain the cause or causes of the phenomenon being investigated. Thus a theory is usually proposed when convincing evidence from laboratory has corroborated a hypothesis.

#### **5. Conclusion (Inference)**

This stage is the culmination of the process of the scientific methodology. The inference drawn from the research can be presented in the form of a book as in seminar presentation or publication in scientific journal. It should be known that since this is a scientific work, the important thing to note is the elimination of bias or prejudice. Theory formulation is part of the conclusion because it explains the problem. A good theory that withstands refutation gains total acceptance. When it is proven to be universally valid or true, with high degree of probability and acceptability it becomes a law. We should note that old theories do not necessarily become incorrect but merely become obsolete. New theories emerge to replace the existing ones. This is as such a guarantee for the development of science and human knowledge.



### CHAPTER THREE

## PHILOSOPHY OF SCIENCE

Philosophy of science is the philosophical study of the foundations, presuppositions, assumptions and implications of science.

Philosophy of science seeks to explain issues such as the nature of scientific statements and concepts, the way in which they are produced, how science explains, predicts and harnesses nature. In brief philosophy of science is concerned to analyze the science project.

Historically philosophy of science is a relatively new area of study. Its origin dates back as recently as the "Novum Organum", the 17<sup>th</sup> century pioneering work of Francis Bacon. The Novum Organum is a book of great importance in the development of modern science and the scientific method. Before the emergence of this discipline, the issues it treats were part of epistemology or theory of knowledge; hence it is in actual fact an old discipline.

The origin of philosophy of science can be traced back to the debate between two schools of thought or philosophical systems in Europe namely rationalism and empiricism. The rationalists such as René Descartes, Benedict Spinoza and G. Leibniz emphasize that reason is the major source of man's knowledge. Empiricist such as John Locke, David Hume and George Berkeley emphasize that sense experience is the major source of man's knowledge.

In his work "critique of pure reason" Immanuel Kant tries to resolve the conflict between the two epistemological schools by developing a critical mediation. To resolve this, Kant posited that all knowledge begins with experience (*a posteriori knowledge*) but not all knowledge arises out of experience (*a priori knowledge*). For Kant both senses and reason complement each other. They both help us with sensibility and understanding respectively. The result of his mediation is known as synthetic a priori knowledge.

Consequently, Kant distinguished between phenomenal reality and noumenal reality. While the former refers to the world as we experience it, the latter refers to intelligible, non-sensual reality or the thing-in-itself.



While phenomenal reality is the object of scientific investigation, noumenal reality is associated with philosophy. Thus with Kant, there was a formal separation between science and philosophy. But interestingly, Kant maintained that rather than being diametrically opposed to each other, both realms (phenomenal and noumenal) complement one another. While the phenomenal realm supplies us with knowledge of reality external to us, the noumenal realm helps us to organize the raw materials presented by our senses. This shows that while the former increases our knowledge, the latter reminds us of the limits of our knowledge. Consequently, the latter (which is philosophy in general and philosophy of science in particular) helps us to tackle the problems that arise from the former (science).

### **Notable Philosophers of Science**

Albert Einstein, Alfred Ayer, Alfred North- Whitehead, Aristotle, August Comte, Bertrand Russell, Charles Sander Pierce, David Hume, Ernest Nagel, Fredrick Engels, Galileo Galilei, George Berkeley, Immanuel Kant, John Dewey, John Stuart Mill, Niels Bohr, Paul Fayerabend, Plato, Roger Bacon, Rudolf Canap, Sir Francis Bacon, Sir Isaac Newton, Sir Karl Popper, Thomas Kuhn, William Whewell.

### **David Hume**

Born on 7<sup>th</sup> May 1711 Edinburg Scotland Great Britain and died on 25<sup>th</sup> August 1776 at the age of 65. He is a philosopher of the 18<sup>th</sup> century and notable ideas accredited to him include problem of causation, induction and some others. This Scottish philosopher, historian, economist and essayist is best known today for his highly influential system of radical philosophical empiricism, skepticism and naturalism.

### **The problem of induction**

The cornerstone of Hume's epistemology is the problem of induction. Here his skepticism about power of reasoning is most pronounced. The problem revolves around the plausibility of inductive reasoning-that is reasoning from observed behavior of objects to their behavior when unobserved. Hume argues that no form of justification will rationally warrant our inductive conclusions because they may fail someday. Hume's solution to this problem is to argue that rather than reason, natural instincts explain the human practice of making inductive inferences. He asserts that "nature by



an absolute and uncontrollable necessity has determined us to judge as well as to breath and feel”.

Although the problem of induction dates back to the Pyrrhonism of ancient philosophy as well as the Carvaka school of Indian philosophy, David Hume introduced it in the mid 18<sup>th</sup> century with the most notable response provided by Karl Popper two centuries later.

### **Karl Popper**

He was born Karl Raimund Popper on 28<sup>th</sup> July 1902 and Died on 17<sup>th</sup> September 1994 at the age of 92. An Austro-British philosopher of science and professor of the 20<sup>th</sup> century with notable ideas such as bold hypothesis, critical rationalism, falsificationism and a few others. Among his contributions to philosophy is his claim to have solved the philosophical problem of induction.

### **Conjectures and Refutations**

Conjectures and refutations: the growth of scientific knowledge is a book written by Karl Popper published in 1963. This book is a collection of his lectures and papers that summarized his thoughts on the philosophy of science. Popper suggested that all scientific theories are by nature conjectures and inherently fallible and that refutation to old theory is the paramount process to scientific discovery. Should any new theory survive such refutation, it would have a higher verisimilitude and therefore popper concluded closer to truth.

### **Principle of falsifiability**

The principle of falsifiability or refutability of a statement, hypothesis or theory is the inherent possibility that it can be proven false. A statement is called falsifiable if it is possible to conceive of an observation or an argument which negates the statement in question. The concern with falsifiability gained attention by way of philosopher of science Karl Raymond Popper's scientific epistemology known as “Falsificationism”

### **Verisimilitude**

Verisimilitude is a philosophical concept that distinguishes between the

relative and apparent (or seemingly so) truth and falsity of assertions and hypothesis. The problem of verisimilitude is the problem of articulating when it takes for one false theory to be closer to the truth than another false theory. The problem was central to the philosophy of Karl Raymond Popper.

### **Alfred Jules Ayer**

Born on 29<sup>th</sup> October 1910 London England and died on 27<sup>th</sup> June 1989 aged 78. A philosopher of the 20<sup>th</sup> century with notable ideas such as logical positivism, verification principle and a few others. He is known for his promotion of logical positivism particularly in his book titled Language, Truth and Logic (1936) and the Problem of Knowledge (1956)

#### **Verification principle**

In his book Language, Truth and Logic, Ayer presents the verification principle as the only valid basis for philosophy. Unless logical or empirical verification is possible, statements like God exists or charity is good are not true or untrue but meaningless and may be excluded or ignored.

### **Thomas Kuhn**

Born July 18<sup>th</sup> 1922 Cincinnati, Ohio and died in 1996 at the age of 73 at Cambridge Massachusetts. He is a philosopher of science of the 20<sup>th</sup> century with notable ideas such as Paradigm shift, incommensurability, normal science and a few others. This American physicist, historian and philosopher of science wrote the controversial book "structure of scientific revolutions" which was influential in both academic and popular circles. He introduced the term "paradigm shift" which has become an English language idiom.

Kuhn made several notable claims concerning the progress of scientific knowledge; that scientific fields undergo periodic "paradigm shift" rather than solely progressing in a linear and continuous way and that these paradigm shifts opens up new approaches to understanding what scientists would never have considered valid before and that the notion of scientific truth at any given moment cannot be established solely by objective criteria but is defined by a consensus of a scientific community. Competing paradigms are frequently incommensurable; that is they are



competing and irreconcilable accounts of reality. Our understanding of science can never solely rely on objectivity alone. Science must account for subjective perspectives as well since all objective conclusions are ultimately founded upon the subjective conditioning /worldview of its researchers and participants.

### **The structure of scientific revolutions**

The structure of scientific revolution was originally printed as an article in the international encyclopedia of unified science published by the logical positivists of the Vienna circle. In this book, Kuhn argued that science does not progress via a linear accumulation of new knowledge, but undergoes periodic revolutions also called "paradigm shift" in which the nature of a scientific inquiry within a particular field is abruptly transformed.

In general science is broken up into three distinct stages namely: pre-science, normal science and revolutionary science. Prescience lacks a central paradigm and is followed by normal science during which scientists try to enlarge the central paradigm by puzzle-solving. During the period of normal science the failure of a result to conform to the paradigm is seen not as refuting the paradigm but as the mistake of the researcher (opposing Popper's falsifiability criterion). As anomalous results builds up, science reaches a crisis, at which point a new paradigm which subsumes the old result along with the anomalous results into one framework is accepted. This is termed revolutionary science.

### **Paul Fayerabend**

Born January 13 1924 in Vienna Austria and died on 11<sup>th</sup> February 1994 (aged 70) in Switzerland. A philosopher of science of the 20<sup>th</sup> century with notable ideas such as epistemological anarchism. Fayerabend became famous for his purportedly anarchistic view of science and his rejection of the existence of universal methodological rules. He is an influential figure in philosophy of science and also in the sociology of scientific knowledge.

### **Nature of scientific method**

In his book "Against method and science in a free Society" Paul



Feyerabend defended the idea that there are no methodological rules which are always used by scientists. He objected to any single prescriptive scientific method on the grounds that any such method would limit the activities of the scientists and hence restrict scientific progress. In his views, science would benefit from a dose of theoretical anarchism. He particularly ruled out falsificationism saying that no interesting theory is ever consistent with all the relevant facts. This is because falsificationism insists that scientific theories should be rejected if they do not agree with known facts.

### **Occam's razor**

Occam's razor is another method in the philosophy of science. It is a logical principle attributed to the medieval philosopher—**William of Occam**. The principle has been used for choosing between equally explanatory hypotheses (that is theories) about one or more observed phenomena. The principle states that one should not make more assumptions than the minimum required. It admonishes us to choose from a set of otherwise equivalent models of a given phenomena, the simplest one. Occam's razor helps us to shelve those concepts, variables or constructs that are not really needed to explain the phenomenon. By this development models will become easier thereby eliminating to a greater degree inconsistencies, ambiguities and redundancies.

## **PHILOSOPHY AND SCIENCE: RELATIONSHIP AND DIFFERENCES**

### **Relationship between philosophy and science**

1. The main of philosophy and science is to understand the world, to obtain the knowledge of the facts, laws and process of nature and to use them for man's advantage.
2. Philosophy and science both try to understand the world through reflective thinking. In their search for truth both are critical, open minded and impartial and are interested in organized and systematized knowledge.
3. They both emphasize methods. The method of deduction and analysis are very important in philosophy while the sciences emphasize both the method of deduction and induction to justify and prove their findings.
4. Philosophy and science are rationalistic, systematic and objective in



approach. They demand for provable or demonstrable evidence or grounds of belief to establish them.

### **Differences between philosophy and science**

1. Philosophy investigates reality as a whole while science investigates aspects of reality
2. Philosophy approaches the study of reality from the perspective of its ultimate principle while science studies reality from its proximate cause.
3. Philosophical knowledge is perceived as rational and concerned with causal relations and essences while science arrives at knowledge through experimental or observable phenomena.
4. Philosophy ask question of a claim to knowledge and makes statements of probability while science tries to give factual a factual knowledge that is certain.
5. Philosophy classifies things in the world in theoretical categories. It tries to give objective and rational proof of accepting postulation and belief while science on the other hand classifies things in the world in practical or experimental procedures.
6. Philosophy is interested in personality, in values and in all realms of experiences while science tends to eliminate the personal factors and values in its search for objectivity.

## CHAPTER FOUR

### THE BEGINNING OF SCIENCE

Science is man's effort to understand his world and modify it to suit purpose. But the big question is when, where and how did science began? The answer to this question is not an easy one.

Before the emergence of modern science, science was subordinate either to the tradition of philosophy or the craft. There are two sources of science namely the technical tradition practiced by the artisans and the spiritual tradition by the priests especially in Egypt and the scribes. These two traditions continued for a long time until the philosophers broke off from the priests, scribes and craftsmen. It was not until the early part of modern times that elements from these traditions metamorphosed into a new science.

The content of scientific knowledge is historically structured. Every age had the type of science appropriate to its needs. The origin of science is often traced to the Egyptians and the Babylonians.

Man's greatest discovery –the use of fire and invention –language goes far back to pre-historic times. It was in the pre-historic period too that man began to construct the tools that first enabled him to survive and then to win mastery over the creatures of the earth.

It was only some 6000 years ago that the first authentic records of what we now call science appeared. These records showed that the first traces of man's civilization are found in the valley of the Nile, Tigris and Euphrates. The Nile flows through Egypt and empties its water into the Mediterranean Sea. The Tigris and Euphrates flow into the Persian Gulf through Mesopotamia.

The Egyptians and the Babylonians originated science during the Neolithic age when they settled down to an organized agricultural life and activity. It had been possible to infer that the content of science in these areas were archeological remains.

At the time of the Egyptians and the Babylonians, people who studied plants, animals, stars and other heavenly bodies, rocks and soil were called philosopher. The first philosophers were the first scientists. Reasons were that they presented rational explanation to their environment.



Then there was a movement of human from the Stone Age to bronze. This was necessitated by the need to develop facilities to survive excess land tilling confronting the Neolithic man. In Bronze Age, a shift was witnessed from the use of wood tools to metals. Further exploration of nature and exploitation of its resources culminates in craft tradition. The craft tradition is therefore a specific product of the Bronze Age.

### Africa's contribution

#### Development of calendar

The development of calendar marked another great stage forward in the history of the development of science. It was the fruit of long centuries of patient observation of the heavenly bodies. Astronomy originated with the Egyptians through the study of the heavens, the stars and the weather. They knew the best time to plant their crops was right after the river Nile overflows its bank. Their priests observed that between each overflow the moon rises 12 times. So they counted 12 moons or months and figured out when the Nile would rise again. They knew the year was approximately 365 days and their accuracy led to the invention of the lunar calendar which was constructed as early as 4236BC considered as the earliest fixed date in the history of mankind. They began with the lunar calendar and later developed a more accurate one based upon "sirus" or the Dog Star. The Babylonians were similarly informed and they divided the year into 12 month of thirty days each. The earliest method of marking the season thus was the phases of the moon. The Babylonians developed the solar calendar in which the length of the year was measured by the apparent journey of the sun in the heavens.

#### The present day calendar

The Gregorian calendar is today's internationally accept civil calendar and is also known as the western or Christian calendar. Rome's Vatican City is the birth place of the Gregorian calendar named after Pope Gregory XIII who introduced it.

#### The development of medicine

In medicine Egypt outshone Babylon. They are said to have performed caesarean operations and removed cataract from the eyes. Evidence is found in the Edwin Smith surgical papyrus. This is the oldest document in the history of science. It gives a list of 48 different kinds of surgical cases and tells the physician what to do in each case. Another important medical



landmark is the Elber's papyrus. It contains a description of the vessels that carry air, water and blood from the heart to the various parts of the body. Homer the Greek historian in the odyssey confirmed Egyptian supremacy in the field of medicine saying that in Egypt the men are more skilled in medicine than any of human kind.

The physician of antiquity of any fame was the black Egyptian Imohtep who lived about 2900BC during the third dynasty yet the western world claims Hippocrates from Greece as father of medicine despite the fact that he appeared about 2000 years after imohtep. Imohtep designed the step pyramid which was built in about 2980BC and thus inaugurated the pyramid age in Egypt.

### **Hippocratic Oath**

This is an oath historically taken by physicians. It is one of the most widely known Greek medical texts. In its original form, it requires a new physician to swear by a number of healing gods, to uphold specific ethical standards.

### **Development of writing**

Writing was necessary to keep record of the wealth of the society that is the product of craft. It is important to note that they were not systematically recorded as scientifically generated products. To do this they made imprints on clay tablets which were then backed and presented for future reference. Picture signs were simplified and combined into sentences. The system of writing in which symbols or characters stand for syllables is called syllabary. For example the picture of a bee and a picture of a leaf could stand for "belief". Within the Egyptian writing system, symbols used for ceremonies originally carved on stone monument is called Hieroglyphics. Etymologically from Greek, hieroglyphics means sacred carvings.

### **Development of mathematics**

Mathematics originated in Egypt especially Geometry. The name geometry was derived from the word "geometria" which means "measurement of land". This branch of mathematics called geometry came as a result of the effort of the Egyptians (pharaoh's task collectors) to measure land marks and boundaries so as to be able to collect tax appropriately.



## CHAPTER FIVE

### THE EARLY GREEK PHILOSOPHERS AND SCIENTISTS

The earliest Greek philosophers were the Ionians and they confined their attention to nature, the external world following the ideas they had gathered from Egypt and the oriental world. Their main concern was to investigate the changes or succession of beings and to attempt to discover what was the constant element in the midst of all these changes. They asked then, what is the world made of/ therefore the Ionian cosmology was mainly an attempt to decide what was the primitive material element or stuff (the urstuff) of all things.

#### **Thales of Miletus**

Thales was the first philosopher who presented a rational explanation of the nature of the universe. He teaches that water is the source of all things in the universe. He got the idea from seeing that the nutrient of all things is moisture and that water is the origin of the nature of most things. By careful observation of the heavenly bodies Thales predicted the eclipse of the sun in the year 585BC. He observed the method of land measurement (geometry) by the Egyptians and concluded that the intricate system of triangles, rectangles and spheres could serve some other purpose than measuring or calculating the size of pyramids. He was noted to have invented an instrument for measuring the distance of the ship out in the sea and through his knowledge a canal was constructed for their ships against Persian army. Being a philosopher, he was one of the earliest scientists and engineer.

#### **Anaximander**

Anaximander was a pupil of Thales. He was quick to argue that water could not be the basic substance. To him the stuff cannot be identified since all things were always in conflict. To him the primary element was a neutral element different from all known elements. That stuff or element, to him must be infinite and boundless, eternal and indeterminate and without boundaries. He called it "Apeiron" Anaximander posits that all things emanated or evolved from the sea and then developed into various forms of adaptations to their environment. To him man evolved from a

A. 79. 3  
species of fish. Anaximander was regarded as one of the earliest evolutionists. He was the first among the Greeks to represent the earth on a map though the science of map making (cartography) was known in Egypt and Babylon. According to Anaximander the earth is cylindrical like a drum.

### **Anaximenes**

Anaximenes was the third Ionian philosopher from Miletus who tried to explain the origin or primary stuff of all things in the universe. For him Air was the original or primary stuff. To prove this he used the theory of condensation and rarefaction. All things come from Air and dissolves into Air. The Air is what keeps the earth in place and according to him the earth is flat.

### **Pythagoras**

Pythagoras was believed to have spent 22 years in Egypt and received instructions on mathematics, physics, music, theology and philosophy in the Egyptian mystery school. For Pythagoras nature or the universe is composed of numbers on various shapes. He sees the universe from a mathematical observatory. The mathematical theory called the Pythagorean theory was named after him. The earth for the Pythagoreans was not at the center of the universe as popularly believed. It was also not flat but spherical. They were first to propose a heliocentric conception of the universe.

### **Heraclitus**

Heraclitus was the first Greek philosopher to advance the principle of change as a universal law. Reality for him is change and nothing is permanent, constant or stable. The world is the world of conflict of opposite. The world is an ever living fire; kindle in measures and in measures goes out. To support this theory of universal change Heraclitus is quoted as having made the following statement "that everything is forever in a state of flux" and that "one cannot step into a river twice".

### **Parmenides**

Parmenides identified reality as changeless and that change is an illusion of sense perception. Nothing comes into being and nothing goes out of



being. For anything to come into being it would come from being or none being. If it comes from being then it already being hence cannot come into being again but if it comes from non being, then it is nothing because it is only nothing that comes from nothing.

### **Empedocles**

Empedocles identified four elements that constitute the universe. The eternal elements are air, earth, water and fire. The unification and separating of these elements explain the being or non-being or coming and going of all things. He further classified two forces responsible for both unification and separation of the four elements. The forces are: love and strife (hate). Love unifies the four elements while strife (hate) separates them thereby removing them from existence.

### **Democritus**

Democritus developed the idea first advanced by his master Leucippus. Democritus proposed that matter is made up of atoms and they are infinite in number and too small to be perceived by the senses. Everything in the universe was composed of atoms which were physically indestructible, permanently enduring and in perpetual motion.

### **Plato**

Plato's notable contribution to science is in the field of geometry. He emphasized deductive system and logic in the study of mathematics. In his famous school "academy" he thought that it was more dignifying to seek answers by reasoning rather than experiments. He postulated that the universe rotates and that the heavenly bodies and their movements in the heaven are examples of geometric forms. For Plato the earth is spherical and it rotates. He believes that each of the four elements present in the universe are similar (air, earth, water and fire) in proportion and quantum.

### **Aristotle**

At the age of 18 Aristotle went to Athens and studied zealously at Plato's academy. At the death of his master Plato he later became tutor to young prince Alexander but he later he returned again to Athens where he opened his own school "Lyceum". In his scientific doctrine, Aristotle thought of the heavens as a series of crystalline spheres set one without the other and

turning about the earth which was at the center. Aristotle proposed a geocentric universe. Aristotle divided the physical world into 2 realms, the organic and the inorganic. In biology he treated completely the life and breeding habit of about 540 species of animals. He discovered the basic facts of life before birth (embryology) by experimenting with chicken eggs. Aristotle maintains that our knowledge starts from the senses i.e from particular to the general or universal. He emphasized the inductive method.

### **Aristarchus of Samos (Alexandrian school)**

He flourished in 280 to 264 BC. He taught not long after Euclid. Aristarchus maintained that the planets revolved in circles around the sun which was the centre fire. This astonishingly modern idea won for Aristarchus the title of Copernicus of antiquity.



## CHAPTER SIX

### SCIENCE AND TECHNOLOGY IN THE MIDDLE AGES

The Middle Ages is known as the medieval period. This epoch was dominated by Christian theology and characterized by decline of science. The middle or medieval period can be divided into: the dark ages (450-500AD) and the renaissance (9<sup>th</sup>-15<sup>th</sup> CAD).

This dark ages was a product of the collapse of the ancient Greek city states and the fall of the great Roman Empire. The medieval era emphasized theology and as religion provided solace for the broken hearted through belief and faith, the medieval philosophers reconstructed faith with reason. The period was dominated by the church fathers. The church was the symbol of unity and also constitutes the custodian of knowledge as presented by saints Augustine, Aquinas and Anselm. Aquinas also known as the Christian Aristotle sustained the work of Aristotle, while Augustine sustained the works of Plato.

Aristotelian cosmology (geocentrism) was the dominant basis of science in the dark ages and the scholastic period. This was a period of Arab influence. Islamic learning started to flourish with the decline of intellectual knowledge in Europe. The Islamic scholars made astronomical observation which they used in checking Ptolemaic predictions. They also made improvement in medicine. Important Islamic scholars include Rhazes, Iben-Alhaithan, Avicenna, Averroes and Alfarabi.

## CHAPTER SEVEN

### MODERN PERIOD: SCIENTIFIC REVOLUTION OF THE 17<sup>TH</sup> CENTURY

The 15<sup>th</sup> century ushered in a new and constructive attitude towards the universe. This was a period of the renaissance, a French word meaning "rebirth". At the beginning of the 17<sup>th</sup> century, the works of Bacon, Copernicus, Galileo, Kepler and Newton gave impetus to astronomy and physics. Their important discoveries which marked the awakening of scientific thought dealt a devastating blow to Aristotelian physics. Aristotle's authority was criticized, reduced and replaced by a new view of the cosmos.

#### **Astronomy**

Etymologically astronomy originated from two Greek words "astron" meaning star and "nomia" or "nomos" meaning law or culture. Hence astronomy can be defined etymologically as laws of the stars or culture of the stars depending on the translation. Generally astronomy is a natural science, the study of celestial objects (such as stars, galaxies, planets, moons, asteroids, comets and nebulae) and processes such as supernovae explosions, gamma ray bursts and cosmic microwave background radiation), the physics, chemistry and evolution of such objects and processes and more generally all phenomena that originate outside the atmosphere of Earth.

#### **Geocentrism**

In astronomy, geocentrism, Ptolemaic system or the geocentric model as it is known is a description of the universe where earth is at the orbital centre of all the celestial bodies. This model served as the predominant cosmological system in many ancient civilizations such as ancient Greece including the system of Aristotle and Ptolemy. They believed that the sun, moon, stars and naked eye planets circled earth i.e revolve around the earth. However, the ancient Greeks believed that the motions of the planets were circular and not elliptical, a view that was not challenge in western culture until the 17<sup>th</sup> century through the synthesis of theories by Copernicus and Kepler.



## **Heliocentrism**

This is the astronomical model in which the earth and planets revolve around the sun at the centre of the solar system. Historically heliocentrism was opposed to geocentrism. The notion that the earth revolves around the sun could be traced to Aristarchus of Samos in the ancient world but it attracted little attention. It was not until the 16<sup>th</sup> century that a geometric mathematical model of a heliocentric system was presented by renaissance mathematician, astronomer and catholic cleric Nicolaus Copernicus leading to the Copernican revolution. In the following century Johannes Kepler elaborated upon and expanded this model to include elliptical orbits and Galileo Galilei presented supporting observations made using a telescope.

## **Nicolaus Copernicus**

Nicolaus Copernicus was born on 19<sup>th</sup> February 1473 and died 24<sup>th</sup> may 1543 aged 70. He was a polish renaissance mathematician and astronomer who formulated a model of the universe that placed the sun rather than the earth at the centre of the universe. He published this model in his book "De revolutionibus Orbium Coelestium" (on the revolutions of the celestial spheres) before his death in 1543.

## **Galileo Galilei**

Galileo Galilei was born on 15<sup>th</sup> February 1564 and died on 8<sup>th</sup> January 1642. He was an Italian astronomer, physicist, engineer, philosopher and mathematician who played a major role during the renaissance. He has been called such names as "the father of modern physics", "father of observational astronomy" and "the father of science". His contributions to observatory astronomy include the telescopic confirmation of the phases of Venus, the discovery of the four largest satellites of Jupiter named Galileo moons in his honor and the observation and analysis of sunspots.

He demonstrated that heavier objects do not fall faster than lighter ones. This is because if we take into considerations air resistance, both heavier and lighter objects will hit the ground at the same time. Galileo is known for notable ideas and works including kinematics, dynamics, telescopic observational astronomy and heliocentrism.

Galileo's championing of heliocentrism and copernicanism was

controversial within his life time. The matter was investigated by the roman inquisition in 1615 and they concluded it could be a possibility and not an established fact. He defended his views which attacked pope Urban VIII and thus alienated him and the Jesuits. He was tried by the inquisition, found suspect of heresy, forced to recant and spent the rest of his life under house arrest. His offending publication was banned.

### **Johannes Kepler**

He was born on 27<sup>th</sup> December 1571 and died on 15<sup>th</sup> November 1630. Johannes Kepler was a German mathematician, astronomer and astrologer. A key figure in 17<sup>th</sup> century scientific revolution, he is best known for his laws of planetary motion based on his works "astronomia nova", "harmonices mundi" and "Epitome of Copernican astronomy". These works also provided one of the foundations for Isaac Newton's theory of universal gravitation. Kepler's first major astronomical work "mystery cosmographicum" (the cosmographic mystery) was the first published defense of the Copernican system. His laws of motion states as follows: 1. all planets travel about the sun in an elliptical (oval) path. 2. All planets move faster in its orbits as it nears the sun 3. There is a relation between its distances from the sun the time it takes to make an orbit.

### **Isaac Newton**

Isaac Newton was born on 25<sup>th</sup> December 1642 and died on 20<sup>th</sup> March 1726 aged 84 years. He is known for Newtonian mechanics, universal gravitation, calculus, and Newton's laws of motion, optics binomial series and principia Newton's method.

This English physicists and mathematician described in his own days as a natural philosopher is widely recognized as one of the most influential scientists of all time and a key figure in the scientific revolution. His book "philosophiae naturalis principia mathematica" (mathematical principle of natural philosophy) first published on 5<sup>th</sup> July 1687 laid the foundations for classical mechanics. He derived Kepler's laws of planetary motion from his mathematical description of gravity and used the principle to account for other phenomena which he used to support the heliocentric model of the solar system.

Newton's work on mathematics was referred to as "fluxions" or "calculus".



Newton later became involved in a dispute with Leibniz over priority in the development of calculus.

### **Francis Bacon**

Francis Bacon was born on 22<sup>nd</sup> January 1561 in England and died on 9<sup>th</sup> April aged 65. This English philosopher, statesman, scientist, jurist, orator and author served both as attorney general and Lord Chancellor of England. Bacon has been called the father of empiricism. His works argued for the possibility of scientific knowledge based upon inductive and careful observation of events in nature. He is regarded as the father of scientific method.

### **Novum Organum**

The full original title of this work is "Novum Organum Scientiarum" meaning "new instrument of science" written by Francis Bacon in Latin and published in 1620. The title is a reference to Aristotle's work Organon which was his treatise on Logic and syllogism. In Novum Organum Bacon details a new system of logic he believes to be superior to the old ways of syllogism. This is now known as Baconian method. For Bacon finding the essences of things was a simple process of reduction and the use of inductive reasoning.

### **The four idols of Francis Bacon (Idola Mentis)**

In Novum Organum (the new instrumentality for the acquisition of knowledge) Francis Bacon classified the intellectual fallacies of his time under 4 headings which he called idols. He distinguished them as idol of the cave, idols of the market place, idols of the tribe and idols of the theatre. An idol is an image, in this case held in the mind, which receives veneration but is without substance in it. Bacon did not regard idols as symbols but as fixations.

**1 Idol of the tribe:** These are deceptive belief inherent in the mind of man and therefore belonging to the whole of the human race. They are abstractions or error arising from common tendencies to exaggerations, distortions and disproportion.

**2 Idol of the cave:** These are those which arise within the mind of the individual. This mind is symbolically a cavern. The thoughts of the individual roam about in the dark cave and are variously modified by temperament, education, habit, environment and accident. Thus the man who devotes his mind to some particular branch of learning becomes possessed by his own peculiar interest and interprets all other learning according to the colors of his own devotion.

**3 Idol of the market place:** These are errors arising from the false significance bestowed upon words and this classification Bacon anticipated the modern method of semantics. The constant impact of words variously used without attention to its true meaning which only in turn conditions the understanding and breed fallacies.

**4 Idol of the theatre:** These are errors which arise due to sophistry and false learning. These idols are built up in the field of theology, philosophy and science and because they are defended by learned people and groups they are accepted without question by the masses.

### **Rene Descartes**

Born on 31<sup>st</sup> march 1596 in France and died on 11th February 1650 in Sweden. This French philosopher of the 17<sup>th</sup> century is known for notable ideas such as cogito ego sum, method of doubt, method of normal, Cartesian coordinate system, Cartesian dualism, ontological argument for the existence of God, mathesis universalis and a few others.

A philosopher, mathematician and scientist, René Descartes is known as the father of modern philosophy, much of subsequent western philosophy is a response to his writings. He belonged to the school of rationalism, foundationalism and is the founder of cartesianism. Descartes influence in mathematics is apparent –the Cartesian coordinate system. He is credited as the father of analytical geometry, the bridge between algebra and geometry used in the discovery of infinitesimal calculus and analysis.

### **Features of modern science**

**1. Observability:** as opposed to medieval science which promoted theology and metaphysics as the pinnacle of scientific knowledge, modern



science only references natural objects which can be perceived by the five senses or can be perceived with the aid of instruments. Once facts have been observed, tested and retested, scientists try to arrange their observations in the format of expressions referred to as scientific laws. Observations that cannot yet be tested and proven on a consistent basis are referred to as scientific theory.

**2. Scientific method:** the scientific method is another important component of modern science as it describes the objective basis for testing and communicating results from scientific investigation.

**3. Mathematics:** a strong emphasis on mathematics over philosophy symbols and attitude is another hallmark characteristic of modern science that goes hand in hand with Observability and scientific method.

**4. Two type of science:** modern science can be divided into 2 different branches which are known as applied science and pure science. Pure science describes the science of discovery while applied science describes the process of developing new technology and products for consumers and often results from the experiments and theories of pure science.

## CHAPTER EIGHT

### SCIENTIFIC DISCOVERIES OF THE 18<sup>TH</sup>, 19<sup>TH</sup> AND 20<sup>TH</sup> CENTURIES

The 18<sup>th</sup> century and more precisely the years preceding the French revolution is popularly known as the age of enlightenment. The spirit of the 18<sup>th</sup> century enlightenment was drawn from the scientific and intellectual revolution of the 17<sup>th</sup> century. The enlightenment accepted and popularized the ideas of Bacon and Descartes, of Boyle and Spinoza and more importantly Locke and Newton. It relegated tradition and exalted the powers of human reason and of science and so strongly convinced the regularity and harmony of nature and equally so deeply imbued with the sense of civilization and progress. During the 18<sup>th</sup> C English scientists were primarily experimentalists and the French were essentially theoreticians while applied science moved from immature scientists to the instrument makers and engineers of England and to a lesser extent of France.

The English astronomer Royal Bradley and Maskelyne made notable empirical observations and discoveries, while the French scientist Lagrange and Laplace developed the theory of mechanics and astronomy. In the same vein Antonie Lavoisier worked out the theory of chemical and atomic revolution. Jeremiah Richter and Proust were also scientists of the chemical and atomic theory of the 18<sup>th</sup> century.

The 19<sup>th</sup> century witnessed the rapid growth of science and industry. John Dalton and others advanced the atomic theory. Michael Faraday was the first to discover that electricity must be essentially atomic hence his theory of electrolysis. Charles Darwin published in 1859 his book "Origin of Species" in which he propounded the evolutionary theory. Following the successes he made in research in the areas of fermentation and diseases, Louis Pasteur is regarded as the founder of modern microbiology.

Maria Sklodowska Curie and her husband Pierre in 1898 discovered radium and other substances more radioactive than uranium. These radiations were quantitative very diverse. They are 3 types called alpha, beta and gamma rays.



Soon after the scientific discoveries of Pierre and Maria curie, JJ Thompson and Lord Rutherford discovered a new notion of atom that atoms were not simple but complex, that various radioactive atoms were nature unstable releasing energy as they disintegrate.

In 1900 Max Planck a German physicist through experiments in heat radiation came to the conclusion that an atom never emits energy smoothly and continuously but intermittently in definite quantities or parcels. He called such a definite parcel or discrete unit or bundle of energy 'a quantum' hence the "Max Planck quantum theory".

The discovery of radioactivity made scientists to return to the old abandoned idea that matter was transmutable and convertible to energy. Albert Einstein the German born Jewish scientist expressed this new idea in his famous formulae  $E=MC^2$  In 1905 Albert Einstein came up with the theory of relativity.

## CHAPTER NINE THE ORIGIN OF MAN

### Theories on the origin of life

How did life come about? This is a question that has generated a lot of controversy. Scientists have argued that life that life did not always exist on earth. Various answers have been provided by various sections of life. We shall now look at this various theories of life.

**Theory of spontaneous generation:** this theory holds that living being originated spontaneously from inorganic matter e.g maggot originated from carrion and mice from rubbish. Aristotle, St Thomas Aquinas and other scholastics believed with the ancients that a certain number of living beings originated spontaneously from inorganic matter.

**Theory of planetic origin of life:** this theory holds that life came from some other planets. The view was expressed by Helm Holtz, Lord Kelvin and some others. But this view is highly probably, it does not really offer any solution to the problem since it merely transfers the problem of the origin of life to another planet.

**The theory of organic evolution:** this theory holds that life proceeds from simple to the more complex or from the lower to the higher form. The term higher means increased structural complexity and range of functions or powers. Evolution in the biological sense is a process of growth or development of all forms of life. The theory of evolution hence posits that plants and animals as we see them about us today are the descendants of ancestors, reaching back for millions of years to exceedingly low forms of life or life's beginning.

The doctrine of organic evolution originated with the ancient Greeks but their views are largely speculative. Later with Charles Darwin publication of his origin of species, the theory of organic evolution began to gain wide spread acceptance.

Important landmarks in the history of organic evolution include Lamarck's theory of inheritance of acquired characteristics, Charles Darwin's theory



of natural selection of chance variation. Weismann's theory of germinal continuity, De Vries theory of mutation, Mendel's law of inheritance and Morgan's theory of the genes.

**Teilhard De Chardin's view on the origin of life:** this theory explains the origin of life based on the law of complexity and consciousness which states that increasing complexity is accompanied by increasing consciousness in the process of evolution. Thus to the considerable complexity of cells and viruses corresponds the degree of consciousness and hence of the manifestation of the phenomenon of life.

**Traditional philosophy and the origin of life:** traditional philosophy attributes life to the causality of a vital principle of substantial form. Matter and form are the constitutive principles of all existence. Matter is in potency to form. Matter is substratum of form, in itself the principle of indeterminacy. Form on the other hand gives matter specific determination. Form is the act of all existence, the principle of perfection. It is the thing which makes a thing what it is. According to traditional philosophy the vital principle of plants and animals are not derived from parent organisms but educed from potency of matter.

**The origin of life in the first living organism:** the theory holds that the origin of life is inorganic substance in operation with a higher cause-the first cause, the Supreme Being. Thus the first living beings are not produced by God out of nothing for their material. Substratum pre-existed. God therefore used inorganic substances as instrumental and material causes in the production of the first living beings.

**The Big-Bang Theory:** according to this theory, the universe expanded from an extremely dense and hot state and continues to expand. The big bang theory is the prevailing cosmological model for the universe from the earliest known periods through its subsequent large scale evolution. Since George Lemaitre first noted in 1927 that an expanding universe might be traced back in time to an organizing single point, scientists have built on his idea of cosmic expansion.

## The Origin of Man

There is seemingly divergent view on the origin of man. The one is biological (evolutionary theory) and the other is theological (biblical narrative-creationism).

**The Biblical (theological theory):** this theological theory states that man was created by God. God thus created man in his own image and likeness (Genesis 1:27, 2:7)

**Biological (evolutionary) theory:** in his book "origin of species" Charles Darwin he agreed with views expressed by the ancients- Anaximander, Empedocles, Anaxagoras and Aristotle that the new species evolved from lower ones through a process of selection and adaptation. In his "descent of man" Darwin taught that man must have evolved through a simple organism in a long process of evolution. Charles Darwin's argument in the origin of species implied that man was first cousin to the apes. Since then the impression has been that man evolved from apes or that both have a common ancestry.

## The data of paleontology concerning the origin of man

This section talks about the data of paleontology to see what explanation there is for man's evolution. It deals with the fossils that have been discovered over the years in various parts of the earth. They are discussed below as follows:

**The Cro-Magnon:** these fossils were discovered in southern France and are thought to have lived about 20,000 BC. Its features are indistinguishable from present day man.

**Neanderthal man:** this is much older and is thought to be species of Cro-Magnon man. It was discovered in the valley of the Neander, West Germany. Neanderthal man was an assiduous culture producer-chipped stone artifact. He had hunting tools. His skull was fairly comparable to that of present day man but paleontologists are doubtful of his being the ancestor of the modern man.



**Pithecanthropus or Java man:** discovered in central Java in 1891 is thought to have lived about 700,000 years ago. The skull was ape-like in appearance. He was a human type-erect about the size of the modern man but had a heavily browed skull and a protruded jaw. He is believed to be more skilful than an ape though he might not have been very wise. He was more a creature of impulse than reason.

**Pekin Man or Sinanthropus:** they had very much similarity with Java man but his cranial size was slightly larger. Pekin man was thought to have been a later and more highly developed form of Java man. Culturally he had mastered the use of fire.

**Australopithecus or Southern Ape of Africa:** the cranial appearance of Australopithecus Africanus is generally very primitive but exhibits hominid features. He is said to have been an upright posture like the present day man. Mentally he is thought to have been of the sub cultural level. He was a tool maker. He seems to stand as intermediary between Homosapiens and the lower animals. All these factors have given rise to the conclusion that Australopithecus Africanus was the direct ancestor of man. A similar fossil was discovered in Tanzania and called Ziajanthropus or Tanzanian man. Anatomically it is too primitive to be human but he seems to have developed tools.

**Homo-habilis:** a more developed kind of fossil was later discovered. He had a larger cranial capacity with his dental structure more like that of modern man. Homo habilis had greater capacity for tool making; hence he is called Homo habilis.

**Homo sapiens:** this is the modern man in every way. First of all anatomically without any doubt we see it in his fore-head with reduced orbits, in his well rounded parietal bosses, in his weak occipital crest now below his swelling brain, in his slight jaw with its prominent chin, all these features so well marked in the last cave dwellers are definitely our own. Man is Homo sapiens.

## CHAPTER TEN

### MAN'S ENERGY RESOURCES

Energy is the capacity for performing work. Work on the other hand is the product of a force by the distance through which the force acts; that is to say that work equals force times distance. For any work to be done, some form of resistance must be overcome.

In the sense of the word therefore energy is the cause of work but not the work itself and so should not have identical meaning with work. There are various kinds of energy but of greatest importance among them to living organism is heat, radiant, mechanical and chemical energy.

#### Importance of energy

- 1 Energy is needed to drive life's processes
- 2 Energy enables us to keep going
- 3 Energy is needed to drive all matter on earth
- 4 Man's development depends on his use of energy

The agro-biological capacity of the earth depends ultimately on the solar energy. Man depends for satisfaction of his food needs on the use to which the solar energy is put by living organisms. All forms of life on this planet require energy for growth and maintenance. The primary source of energy is the sun. The sun plays a cardinal role as energy provider for living organisms. The algae, higher plants and certain bacteria capture energy directly from the solar radiation and utilize it for synthesis of essential food materials.

Animals cannot use solar energy directly. They obtain it by eating plants or by eating other animals which have eaten plants. Thus the ultimate source of metabolic energy on earth is the sun. On earth the ultimate source of animal food is plant life (all flesh is grass). Plants acts as potential store of energy. Vast majority of autotrophs posses green pigment (chlorophyll II) which in the presence of radiant energy synthesis organic matter from water and carbon dioxide. This process is called photosynthesis.

On forms of energy are inter-convertible. When conversion occurs they do so according to rigorous laws of exchange. These are laws of thermodynamics.



## **Renewable Energy Source**

1. Solar energy
2. Wood energy
3. Wind and tidal energy
4. Water energy
5. Synthetic fuel

**Solar energy:** this is the energy derived from the sun. It is convertible into other forms of energy for both immediate and future use. For example in photosynthesis green plants convert solar energy to chemical energy. In many industrialized nations of the world like the USA solar energy is used in driving cars, heating rooms and machines and electricity.

**Wood energy:** this is a potentially source of industrial material. Great quantities of wood are pulped and further disintegrated in various ways to provide raw materials for the manufacture of paper, plastics and various chemicals. In wood distilling plants, wood is heated and processed to provide such products such as charcoal, acetic acid, acetone, wood alcohol, turpentine, tars; oils etc. wood is a source of heat and light energy.

**Wind and tidal energy:** when a reasonable amount of air (wind) hits a windmill, power is obtained. Windmill is a machine which is turned by the wind and designed to furnish motive power. Thus windmills acted upon by the wind convert the kinetic energy in winds into mechanical energy of machines for pumping, for operating mills.

Tides which are the periodic rising and falling of the oceans and the waters connected with them, caused by the attraction of the moon and the sun, generate energy which is utilized in commerce, since they enable ships to sail up the mouths of rivers and land in many harbors otherwise too shallow for approach.

**Water energy:** this is also known as water power. This energy is created by the force of moving water. The science of engineering has made tremendous advances utilizing the power of water to promote manufacturing, transportation and hydroelectric enterprise. Water dams are designed for power, irrigation and protection of the lower lands. The turbine, a water wheel using the reaction of an escaping jet of water produces the mechanical energy. In turbine processes, the mechanical energy of the rotors of the turbine is converted to electrical energy.

**Synthetic fuel:** the field of synthetic has developed rapidly since the beginning of the 20<sup>th</sup> C. Among the well known synthetics are the dyestuffs from coal tar. Synthetic gasoline is now produced by the hydrogenation of coal or vegetable matter by cracking of crude oil or by polymerization of natural gases.



27<sup>th</sup> August 2015

**Futo Past Question (Philosophy of Science)**

**2014/2015 session 1hr.30min**

1. Which of these is not a feature of science (a)curiosity (b)surependity (c)irreversibility (d)criticality
2. All the academic disciplines in a university can answer scientific because ... (a) they are awarded degrees (b)they are methodic, systematic with proper object (c)they make use of experimentation (d)they are profit oriented
3. Which type of knowledge aim at doing and making (a)theoretical (b) scientific (c) practical (d)folk
4. Which of these does not apply to pure science (a)to transform nature (b)to understand nature (c)to explain nature (d)to determine the causation of things in nature
5. Identify the fundamental natural science here (a)physics (b)philosophy (c)chemistry (d)biology
6. In a controlled experiment... (a)we keep all other factors constant while trying to vary one (b)we keep one factor constant and vary all others (c)we keep all the factors constant (d)we vary one factor after the other
7. The application of science to serve human needs is called ... (a)development (b)scientific progress (c)civilization (d)technology
8. The attempt to use the cannons and methods of science as a condition of scientificity for every discipline is called ... (a)naturalism (b)operationalism (c)scientism (d)Methodism
9. Which of these is not a soft science...? (a)sociology (b)medicine (c)psychometrics (d)economics
10. Who raised the problem of induction ... (a)Francis Bacon (b) John Locke (c) David Hume (c) Albert Einstein
11. Philosophy of science probes into ... (a)questions of science (b) questions about science (c)questions in science (d)questions on scientific discoveries
12. The most accurate calendar according to the ancient Egyptians is the... calendar (a)solar (b) Luna (c)star (d) Nile
13. In contrast with Plato ... was more a realist, interested in this world



- and in things (a) Aristotle (b) Socrates (c) Thales (d) Pythagoras
14. The scientific method mainly used in Astronomy and Botany is ...  
(a) experimentation (b) trial and error (c) observation (d) statistics
  15. Which is the principal method of discovering and verifying causes...? (a) experimentation (b) trial and error (c) observation (d) statistics
  16. Whereas science is more analytic and descriptive in its approach, philosophy is more (a) prescriptive (b) general (c) deterministic (d) phenomenological
  17. The primary source of energy is... (a) plant (b) wind (c) water (d) sun
  18. ... is not one of the sources of renewable energy (a) fossil fuel (b) geo-thermal (c) nuclear fission (d) solar
  19. Historically, the development of science in the western world is traceable to (a) Egypt (b) Babylon (c) Greece (d) china
  20. Philosophy of ... is concerned with uncovering the presuppositions and predispositions of the scientist (a) law (b) anthropology (c) science (d) history
  21. Atom, according to Democritus, has the following qualities except (a) homogenous (b) incompressible (c) eternal (d) fluid
  22. One of these describes an axiom (a) a self evident truth (b) empirical truth (c) utopic truth (d) probable truth
  23. The Ptolemaic system was all of these except (a) geographical (b) mathematical (c) physical (d) chemical
  24. Formal science utilizes ... to gain knowledge of nature (a) concepts, rules and theories (b) concepts, rules and beliefs (c) rules, theories, brain (d) theories, concepts, will
  25. An example of a formal science is... (a) medicine (b) economics (c) biology (d) mathematics
  26. The steps in scientific method include the following except (a) hypothesis (b) problem formulation (c) observation (d) induction
  27. The force which pulls every object towards every other object in the universe is called (a) centripetal (b) centrifugal (c) contact (d) gravitational
  28. That fire is the cause of being and non being is associated with ... (a) Anaximander (b) Protagoras (c) Heraclitus (d) Thales

29. Primordially speaking, science is said to have originated from  
(a) fire (b) stone (c) water (d) air
30. One of the greatest men in history that promoted 'astronomy' is ...  
(a) Aristotle (b) Plato (c) Euclid (d) Ptolemy
31. The main features of scientific knowledge include these except ...  
(a) objectivity (b) universality (c) reliability and impersonal  
(d) economical
32. Which of these is not a major division of science (a) natural science  
(b) social science (c) applied science (d) technical science
33. The Egyptian priests contributed the following to science except  
in the area of ... (a) medicine (b) astronomy (c) writing (d) all of the  
above
34. Who gave a mathematical demonstration to the heliocentric  
system of the universe (a) Ptolemy (b) Aristotle (c) Pythagoras  
(d) Copernicus
35. Natural science examines objects by means of (a) speculation and  
theorizing (b) experience and speculation (c) observation and  
speculation (d) experience and experimentation
36. The laws which the traditional mind uses to explain nature are ...  
in character (a) objective (b) speculative (c) natural (d) reliable
37. Theories enable us to ... (a) explain, predict and control (b)  
predict, control and instigate (c) explain, control and retard (d)  
explain, retain and digest
38. Observation can be classified into (a) spontaneous and passive  
(b) spontaneous and induced (c) induced and active  
(d) spontaneous and liberal
39. In the light of modern development in physics, all of these are  
correct except the law of (a) conservation of mass (b) immutability  
of energy (c) conservation of energy (d) gravitational force
40. Whose paradigm of science did Francis Bacon attack  
(a) Copernican (b) keplerian (c) Aristotelian (d) Archimedean
41. Which of these is a question for philosophy of science  
(a) investigations into the mechanics of the laws of nature (d) the  
proper application of the laws of nature (c) the relationship  
between the laws of nature (d) the legitimacy of the laws of nature
42. For Karl Popper, when experiments supports a hypothesis we talk



- of ... (a)confirmation (b)verification (c)establishment (d)corroboration
43. Which of these refers to the technological city (a)techno-polis (b)technocracy (c)technophilia (d)technolatry
44. Aristotelian science is not ... (a)hierarchical (b)qualitative (c)teleological (d)mechanistic
45. Energy from waste material can be harnessed in form of ... (a)wind energy (b)water energy (c)bio-gas (d)solar energy
46. The symbols used by the Egyptians for ceremonious inscriptions were called (a)hieroglyphics (b)ideograms (c)phonograms (d)picture writing
47. Inductive method of science and experimentation is said to have been propounded by (a)Newton (b)Galileo (c)bacon (d)Einstein
48. Thomas Kuhn's paradigm shift in science is an indication that (a)experimentation has occurred (b)science is not changeable (c)there is progress in science (d) science is late
49. In the world of medicine, the oath taken by doctors is associated with (a)imohtep (b)Protagoras (c)Socrates (d) Hippocrates
50. These are steps in scientific research except (a)collection of data (b) organization of data (c) data analysis (d) none of the above

## Section Two (Theory)

## ANSWER ANY TWO QUESTIONS

1. Identify and explain any four renewable energy sources.
2. Discuss any four characteristics of science
3. Give five reasons why renewable energy is important for development.

Rain Semester Examination  
Futo Past Question (Philosophy of Science)  
Federal university of technology owerri  
Directorate of General studies

Rain semester examination 2015/2016 academic session  
GST 110: history and philosophy of science. Time allowed: 1<sup>1/4</sup> hours  
date: 23/09/2016

## SECTION A

1. From the etymological consideration, science refers only to .....  
(a) Natural knowledge (b) Traditional knowledge (c) Knowledge (d)

Refined knowledge

2. Philosophy investigates reality as a whole while science investigates ....  
(A) Observations (b) the whole of reality (c) experimental reality (d) aspects of reality
3. Which scientific method has the character of universality and certainty?  
(a) deductive (b) inductive (c) hypothesis (d) universal method
4. Mathematics and logic are classified as ... science (a) applied (b) formal (c) social (d) physical
5. Who wrote the *Novum Organum*? (a) R. Descartes (b) I. Newton (c) G. Berkeley (d) F. Bacon
6. For the logical positivists, Is the hallmark of science. (A) Experimentation (b) verisimilitude (c) verification (d) falsification
7. The method in which we take the nature of certain members of a class as an indication of the nature of the whole membership is .... (a) Statistics (b) trial and error (c) sampling (d) observation
8. These have a claim to science except ... (a) political science (b) astrology (c) geography (d) Psychology
9. The formal science rely most on ... (a) proof (b) experimentation (c) experience (d) induction
10. Which of this is the odd one out? (a) Vulcanology (b) Meteorology (c) Oceanology (d) Entomology
11. Science and non-science meet in .... (a) Recognition of belief (b) recognition of experience (c) recognition of critical thought (d) all of the above
12. Tradition etymologically means ... (a) Historical (b) reliability (c) handing over (c) none of the above
13. These are scientist philosophers except ... (a) Isaac Newton (b) Karl Popper (c) Galileo (d) Einstein
14. These are philosopher scientists except ... (a) I. Newton (b) R. Descartes (c) Thomas Kuhn (d) Karl Popper
15. Which of these is not a type of technology? (a) preservative technology (b) improvement technology (c) implementation technology (d) cultural technology
16. These are non physical science except .... (a) Education (b) Philosophy (c) astronomy (d) clinical psychology
17. The following theories are in science except ... (a) intelligent design (b) quantum theory (c) cell theory (d) evolution theory
18. For Karl Popper, a theory is scientific if it makes clear predictions that



can be .... (a) partially upheld (b) clearly verified (c) unambiguously falsifiable (d) not wholly falsifiable.

19. Science provides ... to common sense phenomena. (a) confusion (b) imitation (c) rejection (d) clarification

20. Which one of these is not presupposition of science? (a) the things of nature disobey physical laws (b) the world is real (c) physical laws direct the real world (d) the simplest is the best explanation.

21. In medieval period, science and philosophy are what.... To theology? (a) auditor (b) Handmaid (c) enemy (d) persecutor

22. Scientificity ordinarily does not imply ... (a) methodic (b) systematic (d) consistency (d) veracity

23. Which is the fundamental science? (a) Physics (b) philosophy (b) astrology (d) mathematics

24. What is the fundamental natural science? (a) Physics (b) philosophy (c) mathematics (d) basic chemistry

25. Which has contributed more in the efficiency and success of modern science? (a) Physics (b) chemistry (c) biology (d) mathematics

26. .... Is an orderly knowledge of things in accordance with their cause in nature (a) Geography (b) Law (c) Science (d) Geology

27. Who is known for theory of General and special relativity? (a) Copernicus (b) Einstein (c) Newton (d) Bacon

28. Who advocated paradigm shift as a part of the structure of scientific revolution? (a) Thomas Kuhn (b) Karl Popper (c) Aristotle (d) Feyerabend

29. Who entered into controversy with religious authorities on an astronomical theory? (a) Einstein (b) Kepler (c) Galileo (d) none of the above

30. The period between the first invention of Agriculture and founding of the cities is known as .... (a) The Neolithic age (b) The Paleolithic age (c) The bronze age (d) None of the above

31. Early civilization was first noticed around these areas except (a) the Tigris – Euphrates valley (b) the Nile valley (c) the Aegean valley (d) the Indus valley

32. Who was regarded as the fore-runner of the heliocentric system of the universe? (a) Aristarchus (b) Eratosthenes (c) Copernicus (d) Ptolemy

33. Scientism is .... (a) established scientific culture (b) over-reverential attitude toward science (c) interaction of culture and society (d) none of the above

34. Which of these represent the highlight of the renaissance period? (a)



Science and technology became combined (b) scientific methodology and experimentation became universal method of science (c) rationalism became more acceptable in science (d) the old view of knowledge was revived.

35. "Dogmatic attitude and Idols of the mind hinder scientific progress". The above statement is ... (a) false (b) partially true (c) absolutely true (d) impossible.

36. Which does not apply in Darwin's theory of Evolution? (a) Natural selection (b) principle of adaptation (c) principle of purpose in nature (d) principle of survival of the fittest.

37. The essence of philosophy of science is to .... (a) Investigate knowledge (b) give factual knowledge (c) solve problems in science (d) question the validity of scientific knowledge

38. The philosopher of science of "no privileged method" of scientific enquiry is ... (a) popper (b) Kuhn (c) Bacon (d) Fayerabend

39. A tentative guess or conjecture used in science to explain certain facts is ... (a) Hypothesis (b) theory (c) Law (d) Explanation

40. Who completed the break from the medieval scholastic method and founded a new inductive method of reasoning? (a) Bacon (b) Fayerabend (c) Kuhn (d) Popper'

41. Which period signifies that of growth in science according to Thomas Kuhn? (a) Pre-paradigm (b) Crisis (c) puzzle solving (d) normal

42. Science is open to new facts by its attitude of ... (a) constant attack (b) constant rejection (c) constant revision (d) constant skepticism

43. A scientific theory emerges when a hypothesis (a) increases in level of attitude (b) enjoys broad explanatory power (c) survives some testing (d) two of the above

44. How is modern science regarded as a rehabilitation of Plato in the conception of the universe? (a) His teleological conception (b) empirical conception (c) His mechanical conception (d) his geometrical conception

45. Which world-view is toppled by the 16<sup>th</sup> -17<sup>th</sup> century revolution in science? (a) thomistic (b) Copernican (c) Pythagorean (d) Aristotelian

46. The proponent of methodless method in science is ... (a) Karl Popper (b) Feyerabend (c) Imre Lakatos (d) Paul Tillich

47. Verisimilitude is attribute to .... (a) Karl popper (b) Thomas Kuhn (c) Paul Feyerabend (d) Lauden

48. On the field of battle where ethical and moral values are appealing for recognition and appraisal, the physical sciences are ... (a) concerned (b)



involved (c) neutral (d) interested

49. The laws which exactly describes the orbits of the planets was discovered by (a) Brahe (b) Copernicus (c) Newton (d) Kepler

50. The important feature of the industrial revolution is ... (a) the switch from cottage mode of production to factory mode (b) division of labor (c) the use of steam power (d) all of the above

## SECTION B

### ANSWER ANY TWO QUESTIONS FROM THIS SECTION

1. Give and briefly explain any five (5) characteristics of modern science.
2. Write on the contributions of any three of these to science (a) Hippocrates (b) Kepler (c) Newton (d) Darwin
3. Explain very briefly any five characteristics of modern technology.

Federal University of Technology, Owerri

Directorate of General Studies

Rain Semester Examination 2016/2017

Course Code: GST 110 Course Title: Philosophy of Science

Date: 16/11/2017 Time: 1hr 30 Mins

Instruction: Answer All Questions in Section One and Any Two in Section Two

1. Who among these is not a philosopher of science? (A) Nicholas Copernicus (b) Karl Popper (c) Paul Feyerabend (d) Thomas Kuhn
2. who among these wrote the Novum Organum (a) Aristotle (b) Bacon (c) Descartes (d) Hume
3. The great physician of antiquity of African origin was ... (a) Edwin Smith (b) Mansa Musa (c) Imohtep (d) Hippocrates
4. Philosophy of science attempts to answer questions such as ... except (a) what is science? (b) What are the aims of science? (c) What is the meaning of scientific laws? (d) What is life?
5. A tentative guess to explain a problem is ... (a) axiom (b) explanation (c) Hypothesis (d) Theory
6. If equals are added to equals, the sum are equal. The statement can be said to be (a) hypothesis (b) axiom (c) laws (d) premise
7. The application of scientific knowledge and research with the aim of developing products or processes is called ... (a) development (b) scientific discovery (c) technology (d) scientific law
8. one of these is the disadvantages of renewable energy (a) it creates unemployment (b) the initial cost is quite high (c) the energy cannot be



stopped (d) you do not need to rely on others

9. The advantage of the non renewable energy is that (a) the sources are cheap and easy to use (b) it helps in stimulating the economy (c) easy to use during the day (d) creating jobs

10. At the time of the ancient Egyptians and Babylonians, people who studied plants, animals, stars and heavenly bodies were called (a) astronomers (b) scientists (c) philosophers (d) naturalists

11. The system of writing in which symbols or characters stand for syllables is called (a) Cuneiform (b) soumeric (c) syllabary (d) papyrus

12. What is scientific theory? (a) personal answer (b) an explanatory account (c) speculative knowledge (d) a guess work

13. Which of these is a natural science? (a) Statistics (b) sociology (c) biology (d) Economics

14. What was the Copernican revolution about? (a) gravitation (b) heliocentrism (c) relativism (d) geocentrism

15. one of the following founded a new inductive method of reasoning that prepared the way of modern experimental science. (a) Einstein (b) Bacon (c) Galileo (d) Newton

16. Caesarean operations were performed in ancient Egypt as recorded in the (a) Egyptian papyrus (b) embers papyrus (c) ancient Egyptian scroll (d) Edwin Smith surgical papyrus

17. the renaissance scientist who first turned telescope skyward and made useful discoveries is ... (a) Copernicus (b) Kepler (c) Galileo (d) Bacon

18. logical positivists are champions of (a) imperialism (b) geocentrism (c) metaphysics (d) empiricism

19. for Francis Bacon, knowledge must start from ... (a) universal (b) general (c) particulars (d) all of the above

20. The opinion that the sun goes around the earth is a theory of (a) geocentrism (b) Thales (c) heliocentrism (d) Heliographics

21. the hypothesis that reduced the earth to insignificant of the universe was made by (a) Brahe (b) Ptolemy (c) Copernicus (d) Galileo

22. in science the simplest explanation is best in (a) Ockham's razor (b) Popper falsifiability (c) Newton's gravitation (d) anything goes

23. non science includes all except (a) astronomy (b) mythology (c) metaphysics (d) c & b

24. the following is father of the inductive method (a) Columbus (b) Kepler (c) Bacon (d) none of the above

25. formal science include (a) chemistry (b) common sense (c) statistics (d) a & b

26. Galileo Galilei appealed to the evidence of ... (a) experiment & hypothesis (b) hypothesis only (c) experiment and observation (d) experiment only

27. Aristotelian science was seen by the modern scientists as a. quantitative



- b. commensurate c. qualitative d. all of the above
28. philosophy of science deals with a. some questions in science b. most questions in science c. few questions in science d. none of the above
29. Non science is not a. systematic, objective, quantifiable b. supported by evidence, certainty, subjective c. subjective, quantifiable, objective d. systematic, objective, quantifiable.
30. The progress in science is through Karl poppers a. falsifiability bb. Verification c. paradigm shift d. deduction
31. Observations could be classified into a. spontaneous or passive b. spontaneous and induced c. passive and active d. active and induced
32. If the experiment shows that the first guess was wrong, the scientist a. abandons the project b. formulates a theory c. formulate and tests a new hypothesis d. make a general conclusion
33. Which of these is true of science and non science a. criticality b. methodical c. experience d. testability
34. for Feyerabend science and non science a. are exactly the same b. are quite different b. differ only in degree not in kind d. all of the above
35. Which of this is not a physical science? A. acoustic b. astronomy c. geophysics d. seismology
36. non -science differs from science because it could be a. tentative b. impersonal c. public d. personal
37. identify a non applied science here a. nuclear physics b. robotics c. ceramics d. toxicology
38. Which of these is not a property of a formal science a. deductive b. experimentation c. analytic d. conceptual
39. Objectivity of science does not imply a. science is public b. science is reliable c. science is impersonal d. science is reality independent
40. what is the goal of the scientific method? A. making prediction b. discovering new thing c. theory formulation d. efficiency in research
41. what is the best form of experiment? A. closed experiment b. sustained experiment c. controlled experiment d. all of the above
42. which of this is not a scientific law? a. law of entropy b. law of thermodynamics c. law of causality d. law of flotation
43. Anaximenes used this as principle for the transformation of air to form other things a. rarefaction and flotation b. rarefaction and condensation c. condensation and flotation d. rarefaction and liquefaction
44. Hippocratic oath is taken by a. doctors b. lawyers c. accountants d. hippolites
45. Which of these is the precursor of modern scientific materialism? A. ancient mechanists b. ancient pluralists c. ancient physicist d. ancient atomists



46. Who among this is the platonic craftsman in the Timaeus ? a. Apollo b. Zeus c. Dimurge d. God
47. Which of these baconian idols is an attack on authority a. idols of theaters b. idols of the cave c. idols of the market place d. idols of the tribe
48. for karl popper when a theory has not been falsified, it is ... a. corroborated b. verified c. proved d. true
49. Who predicted the eclipse of the sun in the year 585BC . a. Anaximander b. Anaximenes c. Heraclitus d. Thales
50. These are scientist philosophers except a. popper b. Galileo c. Newton d. Ptolemy

### Section Two

1. What is renewable energy? Explain its benefits
2. Compare and contrast philosophy and science
3. Write short notes on any of the following a. Isaac Newton b. Karl Popper c. Galileo Galilei d. Paul Feyerabend

## FEDERAL UNIVERSITY OF TECHNOLOGY OWERRI

### DIRECTORATE OF GENERAL STUDIES

#### RAIN SEMESTER EXAMINATION 2017/2018 SESSION

#### COURSE TITLE-PHILOSOPHY OF SCIENCE

COURSE CODE-GST 110

TIME-1:20MINS

**INSTRUCTION: ANSWER ALL QUESTIONS IN SECTION ONE AND TWO IN SECTION TWO**

### Section one:

1. In which sense is political science and physics called sciences (a) They both employ mathematics (b) They both employ rigid experimental method (c) they are systematic and methodic in their approach (d) they are both natural sciences.
2. Which is not true (a) Non sciences are always false (b) Non Sciences are dogmatic (c) Non sciences generalize hastily (d) Non sciences embody contradictions.
3. Two poisons acting together to make each other more poisonous is referred to as \_\_\_\_ (a) pollution (b) Radiation (c) Synergism (d) Fission
4. All these are type of water pollution except (a) toxic substance \* (b) Storm (c) thermal pollution (d) organic substance
5. Which one is the characteristics of a soft science (a) it must be empirical (b) laws are not very rigid (C) laws are constant (d) None of the above



6. Which of these is a basic natural science? (a)philosophy (b)astrology (c)chemistry (d)physics
7. Science is objective because \_\_\_\_ (a)it is public (b)Not a product of emotion and sentiment (c)not subjective (d)all of the above
8. Which of these is not an earth study? (a)geology (b)geography(c) volcanology (d)epidemiology
9. Before the modern times science was dominated by \_\_\_\_ (a)Milesian world view (b)platonic world view (c) Aristotelian world view (d) thomistic world view
10. The very early pioneers of modern science saw themselves as essentially \_\_\_\_ (a)pure scientist (b)philosophers (c) mediators (d) physicist
11. To whom does this term falsification properly belong? (a) Karl popper (b) Francis Bacon (c) feyerebend (d) lakatos
12. Whom do we associate with paradigm-shift? (a)Kuhn(b)Karl popper (c) feyerebend (d) lakatos
13. Whom do we associate with "against method"? (a) Karl popper(b) feyerebend (c) Francis bacon (d) Kuhn
14. Who propounded the idols of the mind? (a)Karl popper (b)Francis bacon(c)lakatos (d)Kuhn
15. Who is the father of the inductive method? (a) feyerebend (b) Francis bacon (c) lakatos (d) Karl popper
16. Which of these is not a property of science? (a)Empirical (b)irreversibility (c) universality (d) probability
17. Which is not true of the law of parsimony(a)complex explanation are always wrong (b)do not multiply entities without necessity (c) seek simpler explanations (d)it could be called the principle of simplicity
18. That science is law-like does not imply \_\_\_\_ (a)it is ordered (b)it is regular (c)it is spontaneous (d)it is predictable
19. Technology is not pure science because \_\_\_\_ (a)it has no knowledge element(b)it is essentially concerned with doing (c)it does not experiment (d)it has nothing to do with science
20. Which is the odd one out? (a)mathematics (b)theoretical computer (c) logic (d) sociology
21. The oath taken by medical practitioners guiding the ethics of their profession is traced to \_\_\_\_ (a)Aristotle(b)Hippocrates (c)Pythagoras (d)Newton
22. Who said that the world is written in mathematical characters? (a)Newton (b)Copernicus (c)Kepler (d)Galileo
23. Who made the first map of the world? (a)Thales (b)Heraclitus (c)Anaximander (d)Plato
24. Who is the early forerunner of the mathematization of the world?



- (a)Pythagoras (b)Galileo (c)Aristotle (d)atomists
25. Who among these is forerunner of modern atomism? (a)Plato (b)Heraclitus (c)Democritus (d)none of the above
  26. That falsifiability and not confirmability is a virtue in scientific theory was established by \_\_\_\_ (a)Kuhn (b)popper (c)lakatos (d)feyerebend
  27. Who was best known for his work "the structure of scientific revolutions"? (a)lakatos (b)popper (c)Kuhn (d)feyerebend
  28. \_\_\_\_ and \_\_\_\_ were the cradle of civilization (a) USA and Russia (b) Egypt and Mesopotamia (c)Greece and Persia (d)Greece and Assyria
  29. Which of the under listed is not a Milesian philosopher (a) Anaximander (b)Parmenides (c)Anaximenes (d)Thales
  30. The ancient Greece philosophers were searching for \_\_\_\_ (a)the purpose of nature (b)The nature of things (c)the utility of nature (d)the creator of nature
  31. For Aristotle, the ultimate constitution of matter which the earliest Greek philosophers were searching for was \_\_\_\_ (a)water (b)air (c)substance (d)to aperiion
  32. Ancient Greek Science had a general feature of \_\_\_\_ (a)Mysticism (b) utilitarianism (c)Naturalism (d) Experimentation
  33. Which of the listed features is not true of the science of the middle ages (a)inductive (b)encyclopedic (c)Bookish (d)rationalistic
  34. \_\_\_\_ was the queen of the sciences during the high middle ages (a)astrology (b)astronomy (c)philosophy (d) theology
  35. The aristotlean idea of the scientific method is generally \_\_\_\_ (a)inductive (b)deductive (c)abduction (d)experimental
  36. Testing a sample is \_\_\_\_ (a)an evidence (b)logical (c) a hypothesis (d)an observation
  37. Which of these is true of science (a)the real is observable (b) the physical world is real (c) is an institution (d) all of the above
  38. The sense makes \_\_\_\_ (a)indirect observation (b)disguised observation (c)spiritual observation (d)None of the above
  39. Scientific conclusions can be \_\_\_\_ (a)modified (b)discarded (c)reformulated (d)all of the above
  40. One of the aims of science is \_\_\_\_ (a)destroying the world (b)controlling the world (c)deceiving the world (d)none of the above
  41. Which of these is not a type of pollution (a)land pollution (b)earth pollution (c)water pollution (d)air pollution
  42. For Feyerebend science is (a)faith like (b)anything goes (c)intuition (d)objective
  43. Technology is the \_\_\_\_ (a)inquiry on science (b)application of science (c)acquisition of science (d)all of the above
  44. Science is tentative because \_\_\_\_ (a)its dogmatic (b)its complete (c)its progressive (d)its saturated
  45. A theory is a



- confirmed \_\_\_\_ (a)conclusion(b)Experiment(c)problem(d)Hypothesis
46. Not everyone sees \_\_\_\_ in an observation(A)Hypothesis  
(b)conclusion(c)law (d)theory
47. The lunar calendar was the result of series of \_\_\_\_ (a)observation(b)experiment(c)hypothesis(d)None of the above
48. Conjectures and refutation can be associated to \_\_\_\_ a)Aristotle (b)Karl popper (c)Rene Descartes (d)Hume
49. The first physician of antiquity of African descent is called \_\_\_\_ (a)Hippocrates (b)Edwin Smith (c)Imhotep(d)Mansa Musa
50. The sun centered universe can be identified as \_\_\_\_ (a)solar universe  
(b)solar power (c)Geocentricism (d) Heliocentricism

### SECTION B

1. Define philosophy of science and explain its three objectives
2. Explain the steps of scientific investigation
3. Define pollution. Explain three types of pollution

### ANSWERS TO PAST QUESTIONS

#### 2014/2015

1. 2. B 3. C 4. A 5. B 6. D 7. D 8. C 9. B 10. C 11. A 12. C 13. A 14. C 15. A 16. B 17. D 18. C 19. C 20. C 21. D 22. A 23. D 24. A 25. D 26. D 27. D 28. C 29. A 30. A 31. D 32. D 33. D 34. D 35. D 36. A 37. A 38. B 39. B 40. C 41. B 42. D 43. - 44. C 46. C 47. C 48. C 49. D 50. D

#### 2015/2016

1. C 2. D 3. A 4. B 5. D 6. C 7. C 8. D 9. A 10. D 11. B 12. A 13. B 14. A 15. D 16. C 17. A 18. C 19. D 20. A 21. B 22. D 23. B 24. B 25. D 26. C 27. B 28. A 29. C 30. - 31. D 32. A 33. B 34. C 35. A 36. C 37. D 38. D 39. A 40. A 41. B 42. D 43. C 44. - 45. D 46. B 47. A 48. C 49. D 50.

#### 2016/2017

1. A 2. B 3. C 4. D 5. C 6. B 7. C 8. B 9. A 10. C 11. C 12. B 13. C 14. B 15. B 16. B 17. C 18. D 19. C 20. A 21. C 22. A 23. D 24. C 25. C 26. C 27. A 28. B 29. D 30. A 31. B 32. C 33. C 34. 35. 36. D 37. 38. C 39. D 40. D 41. C 42. A 43. B 44. A 45. C 46. C 47. A 48. A 49. D 50. A

#### 2017/2018

1. C 2. A 3. C 4. B 5. D 6. A 7. D 8. D 9. C 10. A 11. A 12. A 13. B 14. B 15. B 16. B 17. A 18. B 19. B 20. D 21. B 22. C 23. A 24. A 25. C 26. B 27. C 28. B 29. B 30. B 31. C 32. C 33. D 34. D 35. A 36. D 37. D 38. D 39. D 40. B 41. B 42. B 43. B 44. B 45. B 46. B 47. A 48. B 49. C 50. D

**DON'T FAIL TO PICK UP GST 201 IN YOUR 200 LEVEL**

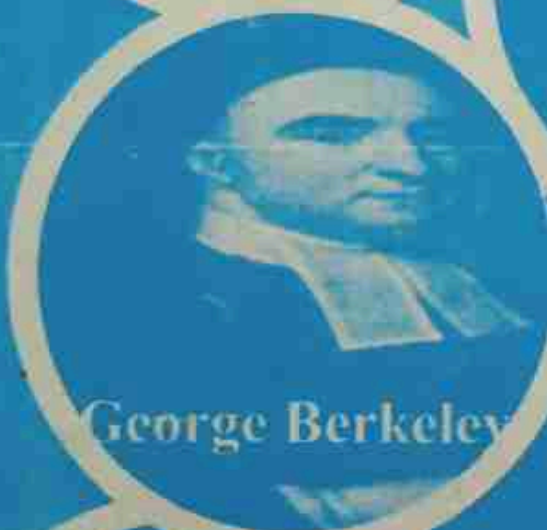
# Great PHILOSOPHERS



Aristotle



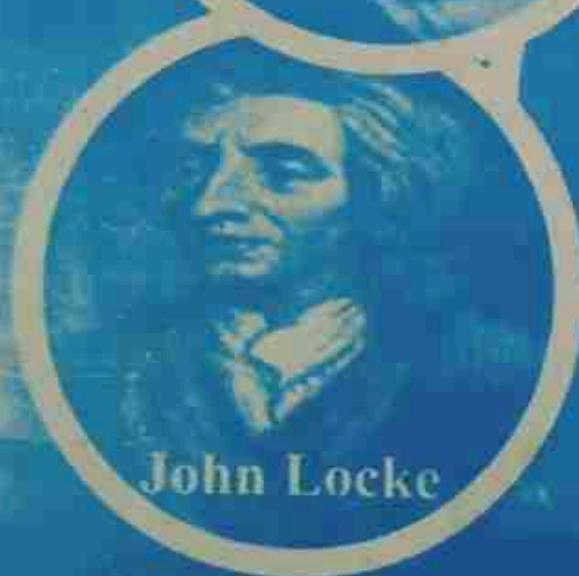
René Descartes



George Berkeley



Plato



John Locke



David Hume

*[Handwritten signature]*