BUREAU'S

HIGHER SECONDARY (+2)

LOGIC

PART - I (FIRST YEAR)

Approved by the Council of Higher Secondary Education, Odisha

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FOREWORD

The Council of Higher Secondary Education, Odisha has restructured the syllabus in Logic for its Examination 2017 and onwards. As usual the Bureau is going to publish Textbook in Logic entitled Bureau's Higher Secondary (+2) Logic in two parts in conformity with the new syllabus. It has been prepared by a team of experienced and eminent teachers of the State selected by the Council.

This new edition has been prepared according to the revised syllabus of CHSE, Odisha. I am thankful to Prof. Dhaneswar Sahu, Prof. Durga Madhab Praharaj, Dr. Kailash Chandra Dash, Sri Niranjan Padhi, Sri Basant Kumar Dash, Dr. Bhaskar Ch. Sahoo and Dr. Susant Kumar Pattnaik for undertaking the revision work of the book.

It is hoped that this book will fulfil the aspirations and cater to the needs of the students and teachers of the State. Comments and suggestion on any aspect of this book will be highly appreciated by the Bureau.

Sri Umakanta Tripathy
Director
Odisha State Bureau of Textbook
Preparation and Production
Pustak Bhavan, Bhubaneswar.

PREFACE

This book has been written to serve as a text book in logic and philosophy for the 1st year of the +2 Course of the Council of Higher Secondary Education, Odisha. A chapter on Indian Philosophy consisting of Buddism and Jainism is incorporated keeping in view the syllabus prescribed by the Council. It covers the entire syllabus, and also has some additional materials for advanced students who may wish to know more about the subject. Since the study of logic aims to develop our skill in correct reasoning, it is best studied by doing logic. Keeping this in mind exercises have been provided at the end of every chapter. Students are well advised to workout the objective-type questions in the exercises of a chapter before proceeding to study the next chapter.

In conformity with the standard practice adopted in most text books the terms 'disjunction' and 'disjunctive' (in disjunctive proposition) have been used in this textbook to signify the inclusive sense of 'either ... or ...'. We have used the term 'alternative' (as it occurs in 'alternative proposition') to signify the exclusive (stronger) sense of 'either ... or ...'. Further, the account of contraposition as a form of immediate inference provided in this book conforms to that provided in standard textbooks in logic. On these two points some logic textbooks give different account. We hope that for the sake of accuracy and uniformity such changes will be incorporated in those textbooks in the near future.

The authors are thankful to the authorities of the Odisha State Bureau of Textbook Preparation and Production for this assignment. Suggestions from teachers and students for improvement and correction of mistakes are welcome. The authors will be amply rewarded if the book is found useful by the teachers and students of logic.

Board of writers

Courses of Studies

First Year (+2) Logic

UNIT 1 : Nature of Logic: Definition of Logic, Structure of Argument, Sentence and proposition, Truth and Validity, Sound and unsound Arguments, Principles of Logic.

Logic and Language: Uses of language, words and terms, Denotation, Connotation and extension.

UNIT-2 : Propositions : Classification of Propositions, Reduction to Logical form. Distribution of Terms, Sevenfold relation of Propositions, Square of opposition of Propositions.

UNIT-3 : Nature, Problem and Procedure of Induction : Induction and Deduction, Primary and Secondary Induction, Procedures of Induction, Problem of Induction.

Induction and Probable Inference : Scientific Induction, Induction by Simple enumeration, Analogy, Statistical Syllogism.

UNIT-4 : Formal Grounds of Induction : Law of Uniformity of Naure, Law of Causation, Qualitative and Quantitative marks of causation, cause and condition, Different views of causation, Plurality of Causes, Conjuction of causes, Intermixture of effects.

Material Grounds of Induction : Observation and Experiment.

Hypothesis : What is Hypothesis ? Conditions of Legitimate Hypothesis,Proofs of hypothesis.

UNIT-5 : Characteristics of Indian Philosophy, Jainism : Syadavada and Anekanta Vada.

Budhhism : Four noble truths and Dependent origination.

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CHAPTER - 1
NATURE AND SCOPE OF LOGIC

1.1 The Discipline of Logic :

We, human beings, are rational animals. As rational beings we seek reasons for our beliefs. It is of course true that we do not always provide reasons for our convictions. But we do recognise the importance of providing reasons or justifications in support of what we claim to be true. The activity of providing reasons for a claim is called reasoning. This reasoning, when expressed in langauge, is called argument. In other words, an argument is a piece of reasoning which consists of a claim together with the reasons in support of that claim. An argument is a sequence of sentences, where one of the sentences is the conclusion (or the claim), and the sentences which provide the reasons for the claim are the premises. Note that the sentences expressing reasons are called premises. And the sentence expressing the claim is called the conclusion. Thus, a sequence of premises together with a conclusion is called an argument. Consider the following example:

(1) If logic were difficult then many students would not like logic.

(2) In fact, many students like logic.

(3) Therefore, logic is not difficult.

This is an argument consisting of three sentences of which (1) and (2) are premises and (3) is the conclusion. In this argument (3) expresses the claim "Logic is not difficult" and in support of this claim the two other sentences (1) and (2) are advanced as evidences. The sentences (1) and (2) together provide the justification for accepting the truth expressed by the sentence (3).

Our intellectual or cognitive activity is argumentative in nature. Scientific activities, as paradigm cases of intellectual activities, are essentially reason-governed. Arguments are the heart and soul of every science or discourse. By the method of rational enquiry science discovers truths, establishes hypothesis and formulates laws. No genuine scientific activity can afford to neglect arguments in the pursuits of knowledge. Like that of scientific activities, in our everyday life also, we normally seek reasons for our beliefs and actions. When our beliefs and actions are not grounded on proper reasons our life often becomes miserable. Suppose someone argues that Ashok is honest because he is well-dressed. This is not a good argument, as the evidence cited in favour of the premise does not provide justification of the claim. Being well-dressed is not at all a reason for believing in the honesty of Ashok, because, there are many well-dressed persons who are not honest. Thus, one who trusts Ashok to be honest on such a wrong ground might land himself in trouble.

We have already noticed that an argument is a sequence of sentences of which one sentence is claimed to be true on the basis of the rest of the sentences. We also noted that the sentence whose truth is being claimed is the conclusion and the sentences that provide the justification for the claim are the premises of the argument. Here we are using the word argument in a board sense to include both good and bad arguments, In other words, whenever some claim is made on the basis of some evidence, we call it an argument. If the evidences justify the claim, we call it a good argument, otherwise it is not.

Logic is a study of the methods and principles of correct or good arguments. It teaches us how to construct good arguments and detect mistakes in our arguments. The knowledge of logic enables us to increase clarity, consistency and cogency of reasoning in our intellectual as well as everyday life. It also helps us to recognise fallacies or errors in our speech and writings. The knowledge of the principles of good reasoning helps us to avoid logical errors that otherwise would creep into our thoughts causing confusions and puzzles. From this we cannot however claim that a logician or a reasonably good logician cannot commit any logical error. A logician, as a human being, may commit logical mistake or even argue wrongly. This is quite possible. What

we are claiming is that a person with the knowledge of logic is better equipped to avoid errors in arguments and argue more efficiently than what he or she would have done without knowledge of logic. Logical thinking is a skill that can be acquired by the study of logic. Logic promotes rational thinking, critical attitude and thereby help us to form a scientific world view. Therefore, it is desirable that one should know the basic principles of good argument. The knowledge of this would place one in a comparatively better position to understand the situation, evaluate beliefs and take correct decisions. Logic also teaches us to appreciate the good arguments and criticise the bad ones advanced by others. Since logic, in general, deals with arguments, let us continue our analysis of the notion of an argument.

1.2 Structure of Argument :

It has been already said that logic is concerned with the analysis and evaluation of arguments. For this we should be able to recognise and identify arguments. It is a fact that our arguments are not always available in a neatly stated form. Thus, to recognise a passage as expressing an argument, we should look at the context of its occurrence. We come across arguments in debates, in a law court, in legislative chambers, in mathematical proofs, etc.. One is also confronted with arguments in ordinary day-to-day life.

As a student of logic, one should be able to determine whether a passage does or does not express any argument. So, an enquiry into the distinction between argumentative and non-argumentative passages will be instructive. Firstly, if in a given passage no statement is connected with the other then surely the passage is not argumentative. Hence the minimum requirement of any passage to express an argument or a series of arguments is that the statements should be connected in such way that they collectively justify or support the truth of a claim. Consider the following passage.

> "The Moon goes round the Earth. All happy men are virtuous. All great scholars are eccentric."

Here no statement is connected with the other. Hence it is not an argumentative passage. Arguments should be distinguished from narrative passages which may consist of loosely connected set of

statements. Consider the following passage. Dasarath was the king of Ayodhya. He had three queens and four sons. Ram was his eldest son. Ram was very kind to everybody. Sita, the princess of Mithila, was his wife.

Here we have narrated several statements but no claim has been made either explicitly or implicitly about any one of them on the basis of the rest. Hence, no argument is involved in the above passage. On the other hand consider the following passage.

All teachers deserve our respect because they are our seniors and our seniors deserve our respect.

This passage is clearly argumentative. All the sentences are well connected. It is claimed that all teachers deserve our respect. This is the conclusion of the argument. In support of this conclusion reasons have been given. The reasons are stated in the two statments: (1) Our seniors deserve our respect and (2) Teachers are our seniors. These two statements are the premises which together provide reasons for the conclusion.

Secondly, to identify an argument, we have to identify its premises as well as the conclusion. Usually in an argument the conclusion is preceded by an expression such as "so", "hence", "thus", "therefore", "as a result", "for this reason", "It is proved that" etc. We call such expressions conclusion indicators. A conclusion is a sentence which begins with any of the conclusion indicator words or phrases. An argument may have also premise indicators. The expressions such as "since", "because", "for", "as", "follows from", "as shown by" etc. are called premise-indicators. Usually premises of an argument begin with or are preceded by the premise indicator expressions. For example, if we assert "P because Q" then Q being preceded by a premise indicator signals that Q is the premise of the argument. The same is the case with conclusion-indicators. Indicator words do not always signal the presence of an argument. For instance, in the sentence "Sita is living in Bhubaneswar since her marriage to Ashok" the word "since" indicates a temporal connection rather than a premise in any argument. In the sentence "Ram resigned from his job because of his illness" the word 'because' indicates a causal connection, not an argument. It

should be further noted that the non-occurance of premise or conclusion indicator ia a passage does not indicate that the passage is not argumentative. In other words, a passage might be argumentative even when the indicator words or phrases are absent. To decide the nature of the passage we have to look at the context of stating the passage.

Thirdly, if a passage consists of just one statement then it does not express an argument. Because, an argument consists of at least one premise and a conclusion. Usually an argument consists of a set of statements which are the premises and another statement which is the conclusion. An argument has the following general from:

P (a set of premises)

Therefore, Q (the conclusion)

Fourthly, there can be passages that are explanatory in nature without being argumentative. If our interest is to establish the truth of a statement say 'Q' on the basis of another statement 'P' then " Q, because P" states an argument. On the contrary, if the truth of "Q" is unproblematic and we have no intention to justify "Q" on the basis of "P", then the formulation "Q because P" is an explanation of why Q occured. Therefore, the difference between an argumentative and explanatory passage is really dependent on our interest or purpose of stating or using the passage in question.

1.3 Definition of Logic :

Logic can be defined as the systematic study of the methods and principles of correct reasoning or arguments. Logic teaches us the techniques and methods for testing the correctness of different kinds of reasoning. It helps us to detect errors in reasoning by examining and analysing the various common fallacies in reasoning.

Let us the examine some proposed definitions of logic. Some logicians define logic as an art of reasoning. According to this view since logic develops the skill or ability to reason correctly, it is an art. As an art, logic provides the method and technique for testing the correctness or incorrectness of arguments. Music, dance, cooking are instances of art. They aim to develop our skills. In these disciplines practice makes a person more skillful. A student of logic is required to

work out the exercises as a part of his or her learning the subject. So logic is an art. Some define logic as both science and art of reasoning. A science is a systematic study of phenomena which are within the area of its investigation. It undertakes to formulate the laws or principles which holds good without exception. Logic is a science as it is a systematic study of the methods and principles of correct reasoning. Logic also studies and clarifies the different types of fallacies which are committed in correct reasoning. A distinction can be drawn between positive and normative sciences. A positive science describes how the facts in its area of investigation actually behave. It arrives at general laws by the methods of observation and experiment. A normative science, on the other hand, investigates the norms as standard that should be applied. Logic is not a positive science since it does not report how people actually reason or argue. Since it deals with the standardas principles of correct thinking, it is a normative science. The use of the word 'reasoning' in the above definitions may be misleading. The term 'reasoning', may signify a mental process or a mental product. In logic, we are not concerned with the actual process of reasoning rather with arguments which is a product. A thought when expressed in language becomes an argument. Thus, the statement that logic is an art and at the same time science of reasoning gives important insights into the nature of logic but as a definition, it is not very accurate.

Some logicians claim that logic is the science of laws of thought. But such a view is not correct because all reasoning involves thinking but all thinking cannot be called reasoning. Logic deals with correct reasoning and not with all types of thinking. There are many mental proceses such as remembering, imagining, day-dreaming etc. which can be instances of thinking without involving any reasoning. Psychology studies all these phenomena, but logic deals only with reasoning. Further logic does not discover any descriptive laws but it formulates the principles of correct reasoning. We can sum up by stating that logic helps one to improve upon the quality of reasoning. It provides technique to strengthen and polish the skill of reasoning. It aims at providing a solid foundation by which one can distinguish between correct and incorrect reasoning.

1.4 Sentence and Proposition :

In the above discussion, we have used both words "sentence" and "proposition" indiscriminately while characterizing arguments. We first said that argument consists of sentences. Subsequently in the previous section we remarked that arguments consist of propositions. This

might create confusion in your mind. You may wonder, does an argument consist of sentences or of propositions? There should not be any confusion on this point. The sentences, which figure in arguments, express propositions. Strictly speaking propositions are the constituents of arguments. One should, however, be clear about the distincton between sentence and proposition.

Firstly, all sentences do not express propositions. Only declarative or indicative sentences express propositions. Questions, (viz., How old are you?, "What is your father?", 'Are you a student?)', commands ('Go there', 'Get out', 'Take whatever available') and exclamation (viz, Oh! What a book!') are sentences but they do not express any proposition. Such sentences do not have any truth value as they do not assert or deny anything. Secondly, a sentence is a linguistic entity belonging to a specific language, whereas propositions are logical entities having no specific allegiance to any particular language. Of course, to express a proposition we always need a sentence but a proposition is different from a sentence. Two or more sentences belonging to the same or to different languages may express the same proposition. For example, "Rama killed Ravana" and "Ravana was killed by Rama" are two different sentences in English but both express the same proposition. Because, the state of affair described by the first sentence is the same as that of the second senence. So far as the proposition is concerned these two sentences express the same proposition. Similarly, the sentence "Ram killed Ravan" can be translated into any other language like Odia, Hindi or Sanskrit, and the corresponding sentences in these languages would express the same proposition. Thirdly, the same sentence may express different proposition uttered at different times and in different places. For example, the sentence "The present Prime Minister of India is a bachelor" uttered in the year 1994 would express a false propositon whereas the same sentence uttered in the year 2002 would express a true proposition. In other words, the state of affair expressed by the two utterances of the same sentence at different times are different. Even if the sentence is the same, the propositions expressed by the sentence at difference times would be different. Thus propositions are distinct from sentences.

1.5 Kinds of Argument: Deductive and inductive

We know that the conclusion of an argument asserts a claim on the basis of the premises. In general, an argument exhibits a relational tie or a relation between premises and the conclusion.

Logic as a system of reasoning aims at characterising this relation. On the basis of the nature of this relational tie we can broadly distinguish between two kinds of arguments viz., deductive and inductive.

In deductive arguments, the premises conclusively justify or support the conclusion. The truth claim expressed by the conclusion is fully supported by the truth claim expressed by the premises. In other words, in case of deductive arguments the truth of the premises absolutely ensures the truth of conclusion. In this sense we call a correct deductive argument demonstrative. If the premises are true, the conclusion must necessarily be true. This means that in a correct deductive argument the premises and conclusion are so related that it is impossible for the premises to be true and the conclusion to be false. Consider the following example,

(1) If logic is interesting then many students like it.
(2) In fact, logic is interesting.
(3) Therefore, many students like it.

Here it is impossible that premises are true and conclusion is false. This is a valid deductive arguement in which the premises provide conclusive grounds for the truth of the conclusion. In an inductive argument the premises do not absolutely or conclusively ensure the truth of the conclusion. If the premises of an inductive argument are all true and the reasoning is good then it is reasonable to believe in the truth of the conclusion. But here we cannot be absolutely sure of the truth of the conclusion. For example, consider the following argument.

(1) Ram is mortal
(2) Hari is mortal
(3) Sita is mortal
(4) .....
(5) .....

Therefore, all men are mortal.

This is an inductive argument. Here even if all the premises are true and the reasoning is good yet the truth of the conclusion cannot be asserted conclusively or with certainty. Because,

even if all the premises are observed to be true and nothing contrary has been observed so far, yet the conclusion being a general proposition cannot be observed to be true as it includes future and unobserved cases. Therefore, the conclusion of an inductive argument is always prone to revision. Hence an inductive argument may be evaluated as better or worse according to the degree of support or backing given to the conclusion by the premises.

Inductive arguments are of great importance for establishing scientific laws and propositions expressing empirical conjectures about the world. Most of our beliefs are based on induction. They cannot be justified by deductive arguments as such cases are empirical generalisations based on uncontradicted experience. For example, we believe that eating rice nourishes us whereas taking arsenic will be poisonous. These beliefs are established by inductive method.

Let us examine some of the misunderstandings usually associated with the distinction between inductive and deduction. It is claimed that induction is a process from particular to general, whereas deduction is a process from general to particular. This is illustrated in the following example.

All men are mortal.
Socrates is a man.
Therefore, Socrates is mortal.

Here the conclusion is a particular proposition and one of the the premises, precisely the major premise, is a general proposition. Of course the reasoning involved in the above argument is correct. This is an instance of valid deductive argument . Therefore, it has been said that deduction is a process from general to particular. This is not always true. Because there are valid deductive arguments whose premises are all general propositions and the conclusion is also a general proposition. Consider the following example :

All men are mortal.
All kings are men.
Therefore, all kings are mortal.

Similarly, there are valid deductive arguments whose premises as well as the conclusion are all particular propositions. Consider the following arguments:

(1) If Ram is honest then Ram is virturous,
In fact, Ram is honest,
Therefore, Ram is virtuous.

(2) Some Odias are scientists.
Therefore, some scientists are Odias.

So, it is not correct to characterise deduction as a process from general to particular. Similarly, we cannot in general claim that in an inductive argument the premises are particular but the conclusion is general. Because, there are inductive arguments whose premises as well as the conclusion are general propositions. Consider the following example,

All cows are mammals and have hearts.
All whales are mammals and have hearts.
All horses are mammals and have hearts.
All humans are mammals and have hearts.
Therefore, all mammals have hearts.

Likewise, we may have a good inductive arguments that may have particular propositions for its premises as well as for its conclusion. This is illustrated in the following inductive argument.

During the last ten years maximum temperature in summer in Rourkela has exceeded 40^0 C., so this year also it will exceed 40^0 C.

The above examples make it clear that it is not correct to characterise deduction as a process from general to particular and induction as a process from particular to general. The fundamental difference between induction and deduction lies on the nature of the relation between premises and the conclusion. In case of deduction, the premises conclusively support the conclusion in the sense that no additional information (or premise) is relevant (i.e. it cannot increase or decrease the validity of a deductive argument). Validity never admits of degree. On the other

hand, the relation between premises and the conclusion in an inductive argument admits of degrees. Even in the best inductive argument premises render the conclusion highly probable. The premises of a good inductive argument never conclusively support the conclusion in the sense that it is possible to discover some additional facts concerning the world that may upset the truth claim made by the conclusion of a well-established inductive argument. Thus, only deductive arguments can be characterised as valid or invalid. Inductive arguments are either strong or weak depending upon the amount of support the premises provide to the conclusion.

We know that probability is the essence of any inductive argument i.e. the conclusion of an inductive argument is probable. Note that mere presence of the word "probability", "probable" etc. in the conclusion never ensures that the argument in question is inductive. Because, there are deductive arguments about the probabilities themselves. Hence we may conclude that an argument is deductive if and only if the conclusion conclusively follows from or is completely determined by its premises, whereas in case of induction, the conclusion is claimed to follow from its premises only with probability.

1.6 The Form and Content of Argument :

We notice from our day-to-day experience that all objects are made of some matter and at the same time also have some form. Consider the example of a table. It is made of wood. Wood is its matter or the content. It has a particular form that ordinarily refers to the shape and size of the table. The shape and size distinguish two or more objects made of wood. For example, though a chair and a table are both made of wood yet they are different in form. The form of chair is different from the form of the table. In other words, both chairs and tables are made of wood i.e. their content or matter is the same but their respective forms distinguish one from the other. An analogous distinction can be made with regard to arguments. For any given argument, it is possible to make a distinction between its from and content.

(i) Two arguments may share the same form or structure yet differ in content. Consider the following examples:

Example 1 :

All men are mortal.

All kings are men.

Therefore, all kings are mortal.

Example 2 :

All mammals have lungs.

All rabbits are mammals.

Therefore, all rabbits have lungs.

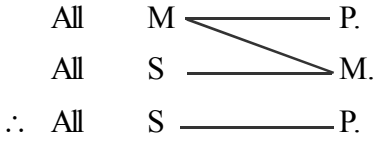
These two arguments have the same form namely

All M is P.

All S is M.

Therefore, all S is P.

Here M, P and S respectively denote the terms, 'man', 'mortal' and 'kings' in the example 1 and "mammals", "lungs" and "rabbits" in example 2. The form of the above mentioned arguments may be exhibited diagrammatically as follows :



Clearly the content or the subject matter of these two arguments are different. Example 1 is about men, mortality and kings and example 2 is about mammals, lungs and rabbits, Thus there are arguments with the same structure having different subject matters. On the other hand,

(ii) The content may be same but the form or structure of the argument may be different. To show this, let us consider these examples.

Example 3 :

No heroes are cowards.

All soldiers are heroes.

Therefore, no soldiers are cowards.

Example 4 :

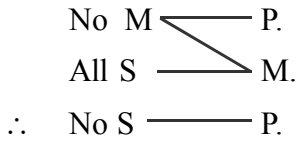
No cowards are heroes.
All soldiers are heroes.
Therefore, no soldiers are cowards.

The content of these two arguments is the same since both are about heroes, cowards and soldiers. But these two arguments have different structures that may be exhibited as follows:

The Structure of example 3 is :

No M is P,
All S is M,
Therefore, no S is P,

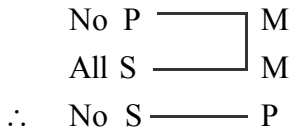
where M, P and S respectively denote heroes, cowards and soldiers. Diagrammatically, it has the following form :



On the other hand, example- 4 is of the form :

No P is M.
All S is M.
No S is P,

where M, P and S denote 'hero', 'coward' and 'soldier' respectively. Diagrammatically it is of the following form :



Clearly the structure of the arguments stated in examples 3 and 4 are different though their content remains the same. Thus, we can notice that content and form are really different and

independent of each other. Now we may end this section by taking note of the fact that logic deals with the form or the structure, not with the content of an argument.

1.7 Truth and Validity :

Truth and validity are two different notions. Truth is predicated of propositions whereas validity is predicated of arguments. Propositions are either true or false. Deductive arguments are either valid or invalid. We have noted earlier that a deductive argument claims to provide conclusive proof for its conclusion. A deductive argument is valid if and only if the premises provide conclusive proof for its conclusion. This notion of validity of deductive argument can also be expressed in either of the following two ways.

(i) If the premises of a valid argument are all true, then its conclusion must also be true.

(ii) It is impossible for the conclusion of a valid argument to be false while its premises are true.

Any deductive argument that is not valid, is called invalid. So, a deductive argument is invalid if its premises are all true but the conclusion is false. Note that in some cases, even if the premises and the conclusion are all true yet the argument may be invalid. In all cases of invalid arguments some of our rules of inference are violated.

The above remarks on deductive validity shows the connection between validity of an argument and the truth or falsity of its premises and conclusion. But the connection is not a simple one. Of the eight possible combinations of truth or falsity of premises and the conclusion and validity or invalidity of arguments, only one is completely ruled out. The only thing that cannot happen is that the premises are all true, the conclusion is false and the argument is deductively valid.

Given below are the other seven combinations of true and false premises and conclusion with example.

(i) There are valid arguments whose premises as well as the conclusion are all true.

Example: All men an mortal.
All kings are men.
Therefore, all kings are mortal.

(ii) There are valid arguments whose premises as well as the conclusion are all false.

Example: All cats are six-legged.
All dogs are cats.
Therefore, all dogs are six-legged.

(iii) There are valid arguments where the premises are all false but the conclusion is true.

Example: All fishes are mammals.
All whales are fishes.
Therefore, all whales are mammals.

(iv) An argument may have true premises and a true conclusion and nevertheless the argument may be invalid.

Example: All men an mortal.
All kings are mortal.
Therefore, all kings are men.

(v) There are invalid arguments whose premises are false but the conclusion is true.

Example: All mammals have wings.
All rabbits have wings.
Therefore, all rabbits are mammals.

(vi) There are invalid arguments in which premises and conclusion are all false.

Example: All cats are biped.
All dogs are biped.
Therefore, all dogs are cats

(vii) Lastly, an argument in which the premises are true and the conclusion is false will be invalid.

Example: All Oriyas are Indians.
Nehru is not an Oriya.
Therefore, Nehru is not an Indian.

We can summarize our findings in the following tabular way.

Premise	Conclusion	Validity of the argument
T	T	Valid Invalid
T	F	xxx Invalid
F	T	Valid Invalid
F	F	Valid Invalid

The above examples show that invalid arguments allow for all possible combinations of true or false premises and true or false conclusion. We cited examples of valid arguments with false conclusion as well as invalid arguments with true conclusions. Thus, it can be noticed that the truth or falsity of the conclusion does not by itself determine the validity or invalidity of the argument. So also the validity of an argument does not by itself guarantee the truth of its conclusion.

We also noticed that valid arguments may have only three out of the four possible truth contributions. A valid argument cannot have true premises and a false conclusion. In other words, if an argument is valid and its premises are true, then we can be sure that the conclusion is true.

1.8 Sound and Unsound Argument :

At this stage we can draw a distinction between sound and unsound arguments. An argument is called sound if and only if it is valid and all its premises are true. Otherwise, the argument is called unsound. The following is an example of a sound argument.

All mammals have lungs.
All rabbits are mammals.
Therefore, all rabbits have lungs.

Here all the premises are true and the argument is valid. Hence, it is a sound argument. On the other hand, an argument is unsound if it is either invalid or some of its premises are false.

For example,

No mammals have lungs.
No whales are mammals.
Therefore, no whales have lungs.

Here the argument is invalid and the premises are also false. Hence it is unsound. Further, even if an argument is valid but some or all of its premises are false then also the argument is unsound. Consider the following example:

No insects have six legs.
All spiders are insects.
Therefore, no spiders have six legs.

Here both the premises are false but the argument is valid. Hence, it is also an unsound argument. Thus mere validity of an argument does not make the argument sound, because there are valid arguments that are not sound. To say that an argument is unsound amounts to the claim that the argument is either invalid or some of its premises are false. Thus the soundness of an argument implies validity as well as the truth of all its premises. But the unsoundness of an argument does not imply invalidity, because there are unsound arguments that are valid.

At this stage the following question may be asked. Why logicians should not confine their attention only to sound arguments? The answer is, we cannot study only sound arguments though it is interesting. Because, to know an argument to be sound we must know that all its premises are true. But knowing the truth of the premises is not always possible. Further, we are often involved in arguments whose premises are not known to be true. For example, when a scientist verifies a scientific hypothesis or even a theory, he or she very often deduces consequences from the hypothesis or the theory in question and compares these consequences with the data and if

the result tallies then the hypothesis or the theory is verified to be true. Here the investigator does not know the truth of the hypothesis or the theory prior to the process of testing. If the truth of the theory or the hypothesis was known to the scientist prior to the verification, the verification would be pointless. So, to confine our attention to sound arguments only would be self-defeating. But this does not make sound arguments logically uninteresting. Because, if by some means, we know that an argument is sound then we may infer the truth of its conclusion.

1.9 The Fundamental Principles of Logic :

We have noted that the task of logic is to study the principles underlying the validity of deductive arguments and the strength of inductive arguments. Since not all deductive arguments are valid, we need to know the principles that ensure a valid argument to be valid and invalid argument to be invalid. It has been suggested that the arguments that satisfy or conform to the laws or principles of logic are valid and arguments that do not do so are invalid. In other words, validity amounts to not violating any law of logic. Logic deals with these principles and also with their interrelation. Out of the various laws of logic there are three fundamental principles, namely, (I) the law of identity, (ii) the law of contradiction (or the law of non-contradiction) and the law of excluded middle. These are known as the laws of thought or fundamental principles of logic. In calling these as laws of thought, there is a danger of interpreting them as psychological laws concerning mental processes of thinking. This would be a misunderstanding of their true nature. These are not descriptive laws. They do not tell us how people think. Rather these are prescriptive in nature. They tell us how one should think or, more precisely, how one should reason. So instead of calling them laws of thought, it is better to call them principles of logic. These three laws are considered as fundamental or basic in the sense that any correct or good argument must conform to these laws. This means that these laws are presuppositions of any good argument. Let us state and explain these laws.

The Law of Identity :

The laws of identity states that everything is identical with itself, i.e. a thing is what it is. In other words, a thing is not other than itself. Symbolically we may say that for anything x, x is x is always true, For example, accepting this law, we assert “table is a table”, “Chair is a chair”,

"Man is a man" and so on. It does not assert anything about the nature of x, it does not tell us whether x in question is white or heavy or soft. It does not tell us about any particular character of the world. It gives us a very useful instruction concerning the use of concepts occurring in an argument. It tells us that in any good argument or in any process of good reasoning, every concept occurring in it must be used in the same sense thoughout the argument. In other words, the meaning of concepts occurring in an argument should remain constant throughout the argument. This law can also be taken as an instruction for assigning truth-values to propositional variables in classical logic. In this sense, it states that distinct occurrences of the same propositional variable always receive the same truth value throughout the argument. In propositional sense it states that every proposition implies itself. Symbolically the law states that for any proposition P, $(P \supset P)$ holds. (Read '$P \supset P$' as 'if P then P'.) This means that if a proposition is used in an argument to state something, then whenever this proposition occurs in the argument it is used to state that thing. It states that the same proposition should not state different things in the same argument. One cannot accept and reject a given proposition at the same breath in any given argument. If we accept and reject a proposition P at the same time in an argument then the very use of P becomes pointless. Hence, for any discourse or argument to be possible, we have to accept the law of identity.

The fundamental nature of the law of identity can be understood in the following way. For example, if we deny this law i.e. if we deny x is x then it implies that there is a denial. Hence by use of the law of identity we have denial is a denial. It is of the form d is d, where d stands for 'denial'. Thus the law of identity is back. The very denial of this law implies its presence. Therefore, without presupposing this law we can not even state or assert anything. For any discourse or argument to be possible we have to accept the law of identity. In this sense, it is a fundamental or basic principle of logic.

The Law of Contradiction (or the Law of Non-contradiction) :

Like that of the law of identity, the law of contradiction, (otherwise called the law of non-contradiction) admits various formulations in different contexts of its use. It states that two contradictory qualities or predicates cannot be asserted with regard to anything at one and the same time. In other words, for anything, it is not the case that it possesses a property and does

not possess that property at the same time. Aristole says, "the same cannot belong and not belong together to the same under same respect". For example let A stand for "to be honest" and B stand for "not to be honest". Then A and B will never belong to the same thing. In other words, it is not possible to assert and deny the same. In its propositional formulation, it asserts that two contradictory statements are not true together. It also suggests that no proposition is both true and false. Symbolically, the law of contradication is represented by the formula $\sim(p \cdot \sim p)$ where p stands for any proposition (Read $\sim(p \cdot \sim p)$ as 'not both p and not p'). This law, like the law of identity, also suggests the method of assigning truth values to propositions. It says that while assigning truth values to the propositions, we should not assign both truth and falsehood to the same proposition. This law is one of the minimum conditions of any good argument. It says that if something is a table, then it is not the case that it is not a table. A thing cannot both be a table and not a table at the same time. Any arguments violating this law would be inconsistent and thereby becomes pointless as it would claim nothing. When we say that a good argument must conform to this law, it implies that it should be consistent.

The law of Excluded Middle :

The law of excluded middle, like the other two above laws, is also a fundamental law in the sense that every good argument must conform to this law. It asserts that everything is either A or not A, where A stands for any quality. A and not-A exhaust the entire discourse. In other words, a thing can be either A or not-A but it cannot be neither. Hence there cannot be an intermediary between contradictory properties. Let A stand for "to be good" and B stand for "not to be good". Then 'either A or B' will belong to everything. In the propositional interpretation the law of excluded middle asserts that every propositon is either true or false. Symbolically, it can be formalised as $(p \vee \sim p)$ is always true for any proposition P. (Read '$p \vee \sim p$' as 'p or not p'). For any proposition p, p admits either the truth value T (for truth) or F (for falsehood). P cannot be neither i.e. there is nothing in between T and F. The third or intermediary value between T and F is excluded.

These three laws in their propositional interpretation are all tautologies and hence are

logically true. Since they are all tautologies, they are equivalent to each other. For that matter they are all equivalent to any of the tautologies. But logicians consider these laws as having a very special status. They are basic or fundamental principles to which any good or correct argument must conform. Further, these laws cannot be proved. Because, to prove them amounts to constructing valid arguments in which each such law must occur as conclusion. Since any valid argument, in general, must conform to these laws, the proofs of such law (if any) as a form of valid argument must also conform to these three laws. This means the proof of these laws would involve the fallacy of pititio principii (i.e. the fallacy of assuming what we wish to prove). Thus we may say that these laws are presuppositions of any good argument. Furhter, the fundamental nature of these laws can be seen in relation to the construction of truth tables. These laws provide us the necessary instructions for assigning truth values to the propositions in classical logic. Each proposition is assigned the value T or F (in accord with the law of excluded middle) but not both (in accord with the law of contradiction) and distinct occurrences of the same variable always receive the same truth value through out the expression (in accord with the law of identify). So these laws are fundamental, self evident and unavoidable for providing consistent arguments in any field of human knowledge.

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SUMMARY

Logic is the study of the methods of evaluating arguments. An argument is a set of propositions consisting of one or more premises and a conclusion. The premises claim to provide reasons in support of the conclusion. Arguments are different from mere narration of facts and explanations. Propositions are typically expressed by declarative sentences. There are two types of arguments — deductive and inductive. A deductive argument claims to provide conclusive support for its conclusion. An inductive argument claims to provide partial support for its conclusion; it cites evidence which makes the conclusion somewhat reasonable to believe. Deductive arguments are either valid or invalid. A valid argument has the essential feature that it is impossible for its conclusion to be false while its premises are true. An argument is invalid if and only if it is not valid. An argument is deductively sound if and only if it is valid and has all true premises. An unsound argument is one which is either invalid or has at least one false premise.

Since logic is a systematic study of methods and principles of correct reasoning and it teaches us the technique of testing the correctness of arguments, it can be viewed both as a science and an art.

There are three fundamental laws of logic. These are (1) the law of identity, (2) the law of contradiction, and (3) the law of excluded middle. These are basic principles of correct thinking which are presupposed in any logical thinking.

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MODEL QUESTIONS

Objective -type

I. Point out in each case whether it is true or false.

1) Logic is the study of methods for evaluating arguments.
2) If a valid argument has only false premises, then it must have a false conclusion.
3) Every valid argument with a false conclusion has at least one false premise.
4) Some arguments are true.
5) Every sound argument is valid.
6) Every invalid argument is unsound.
7) A sound argument can have a false conclusion
8) If an argument is valid and has only true premises, then its conclusion must be true.
9) If all the premises of an argument are true, then it is sound.
10) Every valid argument with a true conclusion is sound.
11) Every valid argument has a true conclusion.
12) If the premises of a valid argument are false, then its conclusion is also false.
13) Every unsound argument is invalid.
14) If an argument has one false premise, then it is unsound.
15) If all the premises of a valid argument are true, then its conclusion is also true.
16) Some arguments are false.
17) Deductive logic is concerned with tests for validity and invalidity of arguments.
18) If a deductive argument has all true premises and a false conclusion, then it is invalid.
19) Every valid argument has true premises and only true premises.
20) If an argument is invalid, then it must have true premises and a false conclusion.

II. Answer the following questions by selecting the correct option:

1. Which one of the following sentences expresses a proposition?

a) What is your name?

b) The sky is blue.

c) Please close the door.

d) May God bless you!

2. Logic deals with

a) arguments

b) law

c) morality

d) explanations

3. Which of the following is a conclusion indicator?

a) for the reason that

b) which implies that

c) in view of the fact that

d) inasmuch as

4. Which of the following is not a premise-indicator?

a) thus

b) since

c) because

d) as

5. Which of the following is a premise indicator?

a) Therefore

b) Hence

c) Because

d) So

6. Which one of the following correctly expresses the difference between deductive and inductive arguments?

a) In an inductive argument, the premises provide some support for the conclusion, but a deductive argument, if it is valid, provides conclusive support for the conclusion.

b) Inductive arguments reason from the general to the particular, while deductive arguments reason from the particular to the general.

c) Deductive arguments reason from the general to the particular, while inductive arguments reason from the particular to the general.

d) Deductive arguments consist of true propositions, while inductive arguments consist of only false proposition.

7. If the purpose of a passage is to account for some proposition, then the passage is probably:

a) attempting to define key terms.

b) an argument.

c) going to fail, since there is no way to account for most propositions.

d) an explanation.

8. In correct reasoning:

a) all the propositions are true.

b) the conclusion supports the premises.

c) the conclusion is never false.

d) the premises support the conclusion.

9. A valid argument must have

a. only true premises.

b. a true conclusion.

c. both true premises and true conclusion.

d. none of the above.

10. If the premises and the conclusion of an argument are all true, then

a. the argument must be valid.

b. the argument must be sound.

c. the argument must be valid and sound.

d. none of the above

11. An invalid argument may have

a. false premises and false conclusion.

b. false premises and true conclusion.

c. true premises and true conclusion.

d. any of the above.

12. If an argument is valid then

a. it must be sound.

b. it cannot be sound.

c. it is sound only if all its premises are true.

d. it is sound but has false premises.

13. If an argument is valid then

a. it is impossible for its premises to be true when the conclusion is false.

b. it cannot be sound.

c. it is possible for its premises to be true when its conclusion is false.

d. none of the above is true.

14. A sound argument

a. may have a false premise.

b. may fail to be valid.

c. may have a false conclusion.

d. none of the above.

III. Match the descriptions given in the right with the words given in the left.

1. Valid	A.It is either true or false.
2. Deductively sound	B. An argument that is either invalid or has a false premise
3. Proposition	C. The part of logic concerned with tests for validity and invalidity of arguments.
4. Deductive logic	D. A valid argument with (all) true premises.
5. Inductive logic	E. The part of logic concerned with tests for strength and weakness of arguments.
6. Logic	F. The study of methods for testing whether the premises of an argument adequately support its conclusion.
7. Argument	G. A set of propositions consisting of a conclusion and one or more premises in support of the conclusion.
8. Deductively unsound	H. It is impossible for the conclusion to be false while the premises are true.

Essay-type questions:

1. What is an argument? Point out the distinction between deductive and inductive arguments.
2. Explain the nature of Logic.
3. Distinguish between:
   (a) truth and validity
   (b) sentence and proposition
   (c) valid and invalid arguments
   (d) arguments and explanations
4. State and explain the fundamental principles of logic.
5. What are the principles of logic? Explain.

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CHAPTER - 2
LOGIC AND LANGUAGE

2.1 Uses of Language :

Logic, as we have said earlier, deals with the analysis and evaluation of arguments. Since arguments are expressed in language, the study of arguments requires that we should pay careful attention to language in which arguments are expressed. If you reflect on how language is used in everyday life, you can notice that our ordinary language has different uses. Language has a variety of functions. By using language we do various things like stating facts, reporting events, giving orders, singing songs, praying God, making requests, cutting jokes, asking questions, making promises, greeting friends and so on. These are wide varieties of language uses. We will not make any attempt to provide an exhaustive list of language uses. Rather we shall discuss here a broad classification of some of the important uses of language. There are three important uses of language that we shall discuss here. These are: (a) *Descriptive*, (b) *Emotive,* and (c) *Directive* uses of language.

(a) Descriptive Use of Language :

Language is often used to describe something or to give information about something. So the descriptive use of language is also called informative use of language. When a sentence is used descriptively it reports that something has some feature or that something lacks some feature. Consider the following two sentences:

1. Birds have feather.
2. Birds are not mammals.

The first sentence reports that having feather is a feature of birds. The second sentence reports that birds do not have some essential qualities found in mammals. In either case it provides information about the world. Both affirmation and denial about things in the world are examples of descriptive use of language. The following are some more examples of language functioning descriptively.

1. Crows are black.
2. Puri is not the capital of Orissa
3. A spider has eight legs.
4. Logic is the study of correct reasoning.
5. The 15th of August is Indian Independence Day.

All these above statements happen to be true statements. However, it should be noted that not only true sentences are instances of informative use of language, but also false sentences are instances of informative use of language. "A spider has six legs" is a false statement since spiders in fact have eight legs. Yet the statement "A spider has six legs", even though false, is nonetheless an example of descriptive use of language.

When language functions informatively we can sensibly ask whether what is asserted is true or false. In other words, the question "Is it true?" can be meaningfully asked of all such instances. When language is used to affirm or deny any proposition, its function is informative. Language used to present arguments serves informative function. All descriptions of things, events, and their properties and relations consist of informative discourse. The language of science is a clear instance of descriptive use of language.

(b) Emotive Use of Language :

Language is often used to express our feelings, emotions or attitudes. It is used either to express one's own feelings, emotions or attitudes, or evoke certain feelings, emotions or attitudes in someone else, or both. When one expresses feelings while alone, one is not expressing it to evoke feelings in others. But very often we attempt to move others by our expressions of emotions. In all such cases language is used emotively. Consider the following utterances:

1. Jai Hind!
2. Cheers!
3. It is disgusting!
4. It is too bad!
5. It is wonderful!
6. Let us win this game!

In appropriate contexts all these can count as instances of language functioning emotively.

If a sentence is followed by an exclamation mark, then very likely it is used emotively. The language of poetry also provides examples of language serving the expressive function. Emotive use is different from descriptive use of language. Emotive or expressive discourse is neither true nor false. When language is used emotively, it cannot be characterized as true or false. We can, however, respond to it by asking questions such as "Is the person sincere?" and "How should I feel?" Expressive use of language is also different from directive use of language.

(c) Directive Use of Language :

Language is often used to give direction to do or not to do something. Commands, requests, instructions, questions are instances of directive use of language. Consider the following examples:

1. Finish your homework.
2. Wash your clothes.
3. You should wear helmet when riding a scooter.
4. Don't smoke.
5. Are you feeling well?
6. Will you please help me?

In all these above examples language is functioning directively. Anyone who utters any of these sentences, in a typical situation, is directing someone to do something or to respond in an appropriate manner. In all instances of language functioning directively, we can meaningfully ask the question "Should I respond?" You will notice that directive discourse, like emotive discourse, is neither true nor false. But directive discourse, specially the imperative statements, can figure in

some arguments. A command such as "Close the window", or an advice such as "You should wear helmet while riding scooter" is either obeyed or disobeyed, but it is neither true nor false. Though commands, advices, and requests are neither true nor false, these can be reasonable or unreasonable, proper or improper. These characterisations of imperative statements are somewhat analogous to characterisation of informative statements as true or false. Moreover, imperative statements often imply or presuppose the truth of some propositions. If I request you to close the window, my request presupposes the truth of the proposition that the window is open. Since reasons can be cited for or against imperative statements, such statements do occur in imperative arguments. We are not going to discuss the logic of imperatives in this book. In our study of logic we shall restrict our discussion to arguments that are stated in the language that functions informatively.

The study of logic is concerned with language that functions informatively. So it is important to distinguish language that is informative from language that serves other functions. There is, however, no mechanical method for distinguishing informative use of language from language that serves other functions. Grammatical structure of a sentence often provides a clue to its function, but there is no necessary connection between function and grammatical form. We can determine whether the language in a particular context is functioning informatively or not by asking "Is this instance of language being used to make an assertion that is either true or false?" If the answer is "yes" then it is an instance of informative use of language.

It should be noted that language, in particular contexts, very often functions in more than one way. One and the same sentence might have more than one function. For effective communication language is often used deliberately to serve multiple functions. Language used to serve expressive function might contain some relevant information. So also language that is primarily informative may make use of other functions as well. Most discourses in our ordinary communication contain elements from all the three uses of language enumerated above. In logic we restrict our attention to those cases where our discourse is at least partly informative or descriptive.

2.2 Words and Terms :

An argument consists of declarative sentences. We have also noted that the declarative sentences express propositions. As a sentence consists of words, so also a proposition consists of terms. As words are the constituent of sentences, so also terms are the constituent of propositions. Consider, for example, the proposition: "Crows are black". It consists of a subject term "crows" and a predicate term "black" joined together by a copula "are". Similarly, the proposition "All men are mortal" has a subject term "man" and predicate term "mortal". A categorical proposition expresses a relation between a subject term and a predicate term.

A term consists of one or many words. For example, in the proposition "All scientists who are famous are sincere and hardworking persons", the subject term is "scientists who are famous" and the predicate term is "sincere and hardworking persons". Here a group of words together constitute the subject term. The predicate term too consists of several words in this example. The terms in this proposition are many-worded terms.

A term constitutes a unit of meaning in the proposition. It expresses a single idea. The terms in a categorical proposition can be best understood as being about classes and individuals. A term signifies either a class of individuals or an individual. For example, in the proposition "Man is mortal" it is asserted that the class "man" is included in the class of "mortals". Here both the terms are class terms and they can be said to be expressing general ideas. The proposition "Asok is mortal" states that an individual (Asok) belongs to the class of mortals. Here "Asok" expresses a singular idea.

Some words can be independently used as a subject or a predicate term in a proposition. A word, which by itself can designate a term, is called *acategorematic* word. Names of individuals and things, and words designating classes and properties are categorematic. For example, 'Socrates', 'man', 'mortal' are categorematic words, since these words can be independently used as subject or predicate term. Some words cannot be independently used as a term, but can occur as a part of a many-worded term. Words like 'the', 'a', 'of' and 'on' belong to this

category of words. These are called *syncategorematic* words. Words like 'hurray!' and 'oh!' cannot be used to signify a term either independently or in conjunction with other words. These are *acategorematic* words. It should be noted that unless a word is used in a proposition, its nature cannot be determined. Looking to its use in a proposition, it can be determined as *categorematic, syncategorematic or acetogorematic*. For the same word can be used differently.

i) He is intelligent (here intelligent is used *categorematically*)

ii) Intelligient boys are rewarded. (here intelligent is used *syncategorematically*)

iii) How intelligent ! he showed his talent in the competition. (here intelligent is used *acetogorematically*)

Thus looking to the use of a term in a proposition, the nature of the term can be determined. Usually words used as noun, pronoun and adjective are *categorematic,* and words used as verb, adverb, adjective, preposition and conjuction are *syncategorematic* and word used as interjection are *acategorematic.*

Generally categorematic words are treated as terms, but syncategorematic and acetogorematic words are not treated as terms.

We can now sum up our discussion. A term is always a component in a proposition. In a categorical proposition a term is either a subject or a predicate of the proposition. It can be single-worded or many-worded. In a categorical proposition, a term signifies a thing or individual, or a class of things or individuals or a property. We shall have further occasion to discuss the nature of subject and predicate terms in greater detail in Chapter 4.

2.3 Denotation and Connotation of Terms :

Class terms or general terms, such as 'man', 'dog', 'river' etc., have two different kinds of meaning – they apply to things and signify some properties. The things to which a term applies in the same sense constitute its *denotation* and the common and essential properties signified by the term constitute its *connotation*.

(a) Denotation :

A general term applies to several things. In one sense of 'meaning', the things to which a general term applies constitute its meaning. This is meaning in the sense of reference. The things to which a general term applies are called the denotation of the term. This sense of 'meaning' is called the denotative, or referential meaning of the term.

Let us elucidate the idea of denotational meaning with an example. Consider the term 'month'. The term 'month' applies to January, February, March, April, etc. – to all the twelve months. The term 'month' applies equally in the same sense to all these months. When we say that a month has less than 32 days, part of what we mean is that January has less than 32 days, February has less than 32 days and so on. Thus the months January, February, March, etc. constitute the denotation of the term 'month'. The denotation of 'boat' is the set of all boats, the denotation of 'dog' is the set of all dogs, and the denatotion of 'chair' is the set of all chairs that are (or ever have been or ever will be) in the world. The collection of all the objects, individuals or events to which a term applies constitutes the denotation of the term. **The denotation of a term is the collection of individual things to which the term correctly applies**.

One might think that since in course of time old things are destroyed and new things are created, denotation of a term does not always remain constant. For example, one might reason that since people die and babies are born, denotation of 'human beings' would decrease with every death and increase with every birth. But this view is based on a mistake. The denotation of the term 'human' consists of all human beings – living, dead, and the unborn. So, particular deaths and births do not change the denotation of 'human beings'.

(b) Denotation and Extension :

A distinction is sometimes drawn between 'denotation' and 'extension' of terms. It has been suggested that these two should not be used as synonymous expressions. It is pointed out that while denotation consists of all the members of the class-term, its extension consist of all the subclasses included within it. Thus, for example, the denotation of the term 'book' will comist of all the individual books to which the term correctly applies; extension of the term 'book' will

consist of its sub-classes like 'logic books', 'physics books', 'story books' etc. Hence extension of a term consist of classes and denotation of a term consists of individual members.

It can be noticed that a term lacking denotation may still have extension. For example, the term 'unicorn' lacks denotation since there are no such animals in the world, but it still can have extension in the form of having sub-classes such as 'white unicorns', 'black unicorns', 'brown unicorns' and so on. Similarly, terms like proper names lack extension but have denotation.

(c) Connotation :

A general term signifies some properties or qualities on the basis of which we know how to apply the term correctly. All the objects denoted by a given term share some *common* and *essential* attributes. Connotation of a term consists of these common and essential qualities. By 'common quality' we mean the quality shared in common by all the members. By 'essential quality' we mean those qualities without which the term will not apply to something. On the basis of these common and essential attributes we are able to decide whether the term applies to a given object or not. In other words, the set of features shared by *all* and *only* those things to which a term applies is called the connotation of that term. The connotation of the term 'triangle' consists of those attributes common to all triangles and found only in triangles. 'Triangle' means a plane figure bound by three straight lines. 'A plane figure bound by three straight lines' constitutes the connotation of 'triangle'. **The connotation of a term is the set of all and only those properties that a thing must possess for that term to apply to it. The word intension is also used as synonym of connotation.**

The word 'connotation' is ambiguous. It has multiple senses. There are at least three different senses in which words intension and connotation have been used. These are called *subjective*, *objective*, and *conventional* connotation of a term. 'Subjective connotation' of a term is the set of attributes the user associates with that term. It is the set of all the attributes the user believes to be true of the objects denoted by the term. Subjective connotation is psychological in character. It varies from individual to individual and from context to context. It may also vary from time to time for the same person. So, subjective interpretations cannot provide any reliable

guidance to the meaning of a term.

By 'objective connotation' we mean the list of all the properties found in the individuals belonging to the concept. But many of these properties may not be essential for the application of the concept. Let us, for the sake of argument, suppose that all human beings have two legs. Then 'being biped' will be a part of the objective connotation of 'human beings'. But this does not make it an essential property of human beings. If someone loses a leg in an accident, he or she does not cease to be human. Moreover, there are also other biped creatures, e.g. birds, apart from human beings. There is another problem with the idea of objective connotation. Since objective connotation will include all the features common to the objects denoted by the term, it would not be humanly possible to know all of these. Human beings are not omniscient. If meaning is identified with objective connotation, then we shall have to concede that one never knows the complete meaning of the terms one is using. So, objective connotation cannot be the public meaning of a term.

By conventional connotation we mean only those properties conceived to be the necessary and sufficient for ascribing objects to the term. Conventional connotation makes it easy for us to pick out the objects falling under the class term. In logic when we talk of connotation we mean to use it in the sense of conventional connotation. Conventional connotation is the same as logical connotation.

(d) Relation between Denotation and Connotation :

Connotation and denotation are closely interrelated. The following points should be noted with regard to their relation.

(1) Connotation of a term determines its denotation, but denotation of a term does not uniquely determine its connotation. One may know the connotation of a term without knowing its denotation. For instance, even though there are no unicorns in the world, people know the meaning of the word "unicorn" in the sense of knowing its connotation. 'Unicorn' means 'a horse like animal with one long horn on its forehead'. So, one who knows this, knows the connotation of the term, although no one has ever come across

any unicorn in the world. Further, two terms having different connotations may have the same denotation. For example, consider the two terms 'equilateral triangle' and 'equiangular triangle'. The term 'equilateral triangle' means a plane figure enclosed by three straight lines of equal length. The term 'equiangular triangle' means a plane figure enclosed by three straight lines that intersect each other to form equal angles. Notice that these two terms have different connotative meaning but both denote exactly the same set of figures. So, connotation of a term determines its denotation. In other words, the connotation of a term provides us a set of criteria for deciding whether an object falls within the extension of that term. For example, when we come across an animal in a zoo, we decide whether or not it belongs to the class of leopards by seeing whether or not it has the relevant features of a leopard.

(2) Connotation and denotation vary inversely. When connotation increases denotation decreases, and when denotation increases connotation decreases. Some logicians call it the law of inverse variation. Consider the following sequence of terms:

1. 'animal',
2. 'aquatic animal', and
3. 'aquatic animal with fins'.

These terms have been arranged in the order of increasing connotation. The connotation of 'aquatic animal' is greater than that of 'animal'. Aquatic animals have all the qualities common and essential for something to be an animal and in addition to those properties they have the property of living in water. Similarly, the connotation of 'aquatic animal with fins' is greater than that of 'aquatic animal', since aquatic animals with fins have all the properties of aquatic animals plus the property of having fins. So you can see that the three terms are in the order of increasing connotation. You will also notice that these terms are in the order of decreasing denotation. The total number of aquatic animals is less than that of animals, and the total number of aquatic animals with fins is less than that of aquatic animals. Thus when we arranged the terms in an order of increasing connotation, the terms also automatically got arranged in an order of decreasing denotation.

Similar relation of inverse variation can also be noticed if we arrange terms in an order of decreasing connotation.

1. 'aquatic animal with fins'
2. 'aquatic animal'
3. 'animal'

In the above sequence of terms connotation progressively decreases while there is a progressive increase in the denotation of the terms. Thus we have noticed that if we increase the connotation in a series of general terms by including more features, the denotation of the corresponding terms in the series tends to decrease, and if we decrease the connotation in any series of terms, the denotation os the corresponding terms tends to increase.

There are, however, some exceptions to this relation of inverse variation. In some cases an increase in connotation does not result in the decrease in denotation. We observed earlier that the two terms having different connotation might have the same denotation. We cited the case of the two terms 'equilateral triangle' and 'equiangular triangle' to illustrate that point. The same example can be cited to illustrate an exception to the 'law of inverse variation'. Although the term 'equilateral and equiangular triangle' has greater connotation than that of the term 'equilateral triangle', there is no variation in the denotation of these terms. This illustrates the point that increase in connotation is not always accompanied by decrease in denotation.

(e) Relation between Extension and Connotation :

We can notice that there is also a relation of inverse variation between extension and connotation of terms. From the point of extension a higher class (genus) includes a lower class (species). But from the point of view of connotation the lower class (species) includes the connotation of the higher class (genus). Thus as we pass from a species to its genus the extension increases but the connotation decreases. On the other hand, when we pass from a genus to its species there is increase in connotation but decrease in extension. For example, if we increase the connotation of 'humans beings' adding a new proprerty 'educated' then the new term 'educated human being' will have greater connotation but its extension will be less than that of the extension

of 'human being'. Similarly, if we decrease the connotation of 'human beings' by taking out the property 'rationality' from it we get a new term 'animal' with greater extension, since the term 'animal' contains more subclasses than that of 'human beings'. In the above examples we notice that increase in connotation leads to decrease in extension and decrease in connotation leads to increase in extension. Analogously we can notice that increase or decrease in extension will also lead to corresponding decrease or increase in connotation.

(f) Genus and Species :

As already pointed out earlier, genus is a higher class in relation to a sub-class called species. A species is a subordinate class of a higher class called its genus. Genus and species, thus are relative terms. For example, animal is a subordinate class in relation to all living beings, so animal is the species of the genus living beings. But animal is the genus in relation to its subordinate class human beings. Human being is the genus in relation to its spices intelligent human beings. A term having the widest extension which is never a subordinate class to anything, is called ***Summum genus.*** Similarly a term having the narrowest extension which is never a genus is called ***infima species.***

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SUMMARY

Ordinary language has a variety of functions which can be broadly classified into descriptive, emotive and directive uses of language. Logic is concerned with language that functions descriptively or informatively. Grammatical form of a sentence is not a sure guide to its function. Language is very often used to serve multiple functions.

As words are the constituents of sentences, terms are the constituents of propositions. Terms are expressed by one word or many words. A term signifies an individual a property or a class of individuals.

General terms have both denotation and connotation. Denotation of a term consists of the things to which the term applies. Connotation of a term consists of the set of common and essential attributes shared by the objects denoted by the term. The denotation of a term is determined by its connotation, but connotation is not determined by its denotation. Generally, denotation and connotation of terms vary inversely when the terms are arranged in accordance with their subordination. Increase or decrease in connotation of a term results in another term with a corresponding decrease or increase in denotation. So also, increase or decrease in denotation results in corresponding decrease or increase in connotation. A similar relation of inverse variation can also be noticed between extension and connotation of terms.

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MODEL QUESTIONS

Objective type

I. Fill in the blanks by selecting the appropriate word from the options given in the bracket.

1. When someone asserts or denies a fact, it is an instance of _____ use of language. (informative, expressive, directive)
2. "Please close the door." This sentence illustrates the _____ use of language. (informative, expressive, directive)
3. The set of attributes shared by all and only those objects to which the term refers to is called the _____ of that term. (extension, connotation, denotation)
4. Terms having different connotation may have the same _____. (denotation, meaning, intension)
5. When a question is posed in order to request an answer, it is a case of _____ discourse. (descriptive, expressive, directive)
6. The _____ use of language includes both correct and incorrect information. (descriptive, expressive, directive)
7. The _____ connotation of a word for a speaker is the set of all attributes the speaker believes to be possessed by objects denoted by that word. (objective, subjective, conventional)
8. The _____ connotation of a word is the total set of characteristics shared by all objects denoted by that word. (objective, subjective, conventional)
9. The _____ of a term increases when attributes are added to it. (extension, connotation, denotation)
10. The class term "unicorn" has no _____. (extension, connotation, denotation)

II. Point out in each case whether the statement is true or false.

1. The extension of a term refers to its subclasses.
2. The connotation of "town" includes Aska, Burla, Chowdwar, and Dhenkanal.
3. The term "sky flower" has connotation but no denotation.

4. The only function of language is the communication of ideas.
5. Expressive discourse is used to manifest the feelings of the speaker or to evoke them in others.
6. Directive discourse consists of true propositions.
7. "That's too bad" is a directive use of language.
8. The grammatical division of sentences into declarative, interrogative, imperative, and exclamatory corresponds precisely with the functions of sentences.
9. Two words can have the same literal meaning but different emotive meanings.
10. The collection of objects to which a term may be applied constitutes its denotation.
11. The denotation of a term determines its connotation.
12. To talk about the intension of a term is the same as referring to its connotation.
13. Terms with different denotations cannot have the same connotation.
14. Adding more attributes to the connotation of a term may greatly narrow the range of its denotation.
15. Adding additional attributes to the connotation of a term will certainly not increase its denotation.

Essay type

1. Distinguish between different functions of language. Explain the function of language that is important from the point of view of logic.
2. What is meant by denotation of a term? Distinguish between denotation and extension.
3. Distinguish between denotation and connotation of terms. Is there any term which has connotation but no denotation? Discuss.
4. Explain with suitable example the relation of inverse variation between connotation and extention of terms. Can you think of any exception to this relation? Discuss.
5. Distinguish between subjective, objective and logical connotation of terms.

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CHAPTER - 3
DEFINITION AND MEANING

3.1 Verbal and Factual Disputes :

Language is our principal tool for communication. We engage in arguments by using language. Language consists of sentences and a sentence consists of words. If words are not used carefully, it will affect our communication and our ability to create and communicate correct arguments. Sometimes the key words used in our communication are ambiguous or excessively vague. A word or term is ambiguous when it has two or more distinct meanings. For example, the words like 'pen', 'mad', 'mouth' are ambiguous. The word 'pen' stands for a writing instrument; but it also refers to an animal enclosure. The word 'mad' means insanity; but it is also used to mean anger. 'Mouth' can refer to a person's mouth or the mouth of a river. If the speaker uses a word in one sense but the hearer understands it in another sense, controversy is likely to arise. Consider, for example, the following question: 'If a tree falls in the forest and nobody is there to hear it, is there a sound?' Conflicting answers to this question might be due to the ambiguity of the crucial word 'sound' in the question. The word 'sound' can mean sound waves or the sound sensation. If the word 'sound' is used to mean sound waves then there are sounds in the forest when the tree falls, whether or not someone is there to hear it. Alternatively, if the word is used to mean the sensation of sound, then clearly there is no sound when no one is there to experience it.

Words in ordinary language are not only ambiguous, they are also often excessively vague. An expression is vague, if borderline cases for its application occur. In other words, an

expression is vague if it is unclear whether or not the expression is applicable in a particular context. Examples of vague terms include 'kid', 'bald', 'old', 'happy', 'rich', and 'thin'. Another way that vagueness can occur is when an expression has several criteria that must be met for its correct application, and there is no specification of how many of the criteria must be satisfied, or to what degree. Such controversies, which are due to either vague or ambiguous use of words, are needless controversies and should be avoided as far as possible.

Disputes arising out of either ambiguity or vagueness of words are verbal disputes. A verbal dispute can be avoided by stating the sense in which the key words are used. Once the parties to the dispute make clear the sense in which they are using the terms they will realise that their disagreement is on the meaning of their terms and the parties in the dispute might not be opposed to one another. A verbal dispute would disappear once the parties involved in the dispute distinguish between different meanings of the important terms and agree on the meaning of these terms. We can save a lot of time, sharpen our reasoning ability, and communicate with each other more effectively if we watch for disagreements about the meaning of words and try to resolve them whenever we can.

But all disputes are not verbal disputes. Some disputes are genuine disputes in which there is some genuine disagreement between parties. Genuine or non-verbal disputes can be of two kinds. Such disputes involve either *disagreement in attitude* or *disagreement in belief*. Disagreement in attitude arises when two persons or parties express different feelings or attitudes towards the same situation. For example, some people like eggs and some others do not like eggs. Those who like eggs would say that eggs are delicious, but those who do not like would disagree and say that eggs do not have good taste. Here they are expressing their disagreement in their attitude towards eggs. If two persons give different answer to the question whether eggs are good tasting or not, then the fact is that one of them likes its taste and the other does not like the taste. No verbal dispute is involved here, since both the persons agree on the meaning of the words by means of which they convey their respective feelings. This is a case a genuine disagreement in the sense that they have different feelings towards the same situation.

There is an important type of dispute in which parties to the disputes disagree on what they believe to be true. These are factual disputes. People engaged in a factual dispute often agree on the meaning of the words by means of which they convey their respective positions, but they disagree over the truth of some specific proposition. Suppose one person asserts that a spider has eight legs and another person disagrees and claims that spiders have six legs. Further investigation of the matter will settle their dispute in support of the claim that spiders have eight legs, because spiders in fact have eight legs. There are, however, some factual disputes which are difficult to settle because we are not in a position to verify the facts, but in such cases we can say what would settle the issue.

3.2 Definitions :

A definition states the meaning of a term. Since meaning of an expression is explained by its definition, definitions provide a useful method of preventing or eliminating differences in the use of languages. In other words, definitions are essential for preventing ambiguity. We observed earlier that verbal disputes often arise due to use of ambiguous and excessively vague words and phrases. Such disputes can be avoided if we agree on the definition of the key terms in our arguments. Definitions thus help us in correcting mistakes in our reasoning by eliminating ambiguity.

The term to be defined is called the *definiendum*. The word or words used to state the meaning of the term defined is called the *definiens*. In other words, the term sought to be defined is the definiendum and the expression supplying the definition is the definiens. Consider the definition of 'triangle'.

A triangle is a plane figure enclosed by three straight lines.

In this definition the term 'triangle' is the *definiedum* and 'a plane figure enclosed by three straight lines' is the *definiens*. The *definiedum* and the *definiens* are said to have the same meaning. Both are claimed to be synonymous expressions and therefore one can be substituted for the other without any loss of meaning.

A definition is either *reportive* or *stipulativ*e. When a definition states the meaning of a term *as it is used* it is called reportive definition. When it states the meaning of a term *as it is to*

be used it is called stipulative definition. A *reportive definition* of a term reports the way in which the term is already used. It tells us how a term is actually used by the native speakers of the language. Such a definition reports the conventional meaning of a term. It reports the long-established usage of a term. Reportive definitions can be true or false, depending upon the accuracy with which it captures the actual usage of the term. Reportive definitions help to eliminate ambiguity. Reportive definitions also help us to increase our vocabulary by learning the meaning of new symbols by the help of symbols we already understand. Most dictionary definitions are examples of reportive definitions. 'A triangle is a plane figure enclosed by three straight lines' is a reportive definition. So also the definition of 'unicorn' as 'a horse-like animal having a single straight horn projecting from its forehead' is a reportive definition.

A *stipulative definition* assigns a new meaning to a term. By stipulative definitions new terms are introduced into a language or old terms are made precise by deliberately assigning new meaning for the terms. A stipulative definition creates a new usage that did not exist prior to the stipulation. Stipulative definitions have the form "Let us use the word '…' to mean '…'. Stipulative definitions are neither true nor false. One can however judge a stipulative definition to be useful or cumbersome, clear or obscure, but not as true or false. Since the purpose is to introduce a term by assigning a new meaning, no existing convention or usage can be cited for its correctness or incorrectness. A stipulative definition is a proposal or a decision to use a term in a certain sense. When a term is first introduced into a language it gets its meaning by stipulation. For example, when spacecrafts were made to fly to outer space and persons were specially trained to fly these spacecrafts, there was a need to introduce a technical term to refer to such persons. So the term 'astronaut' was coined to mean 'a person who has been trained to travel in a spacecraft'. When the word was first introduced to mean this it was an instance of stipulative definition. Now, however, the term has already gained wide currency and this definition can be cited as an instance of reportive definition.

3.3 Denotative and Connotative Definitions :

We noted earlier that a general term has two kinds of meaning. It applies to certain things and signifies some properties. These two features of a general term are called its denotation and

connotation respectively. Keeping the distinction between denotation and connotation in mind, we can now proceed to discuss the two ways a general term can be defined.

(a) Denotative Definition :

A denotative definition explains the meaning of a term by identifying the things to which the term applies. A denotative definition of the phrase 'the past prime ministers of India' will consist of a complete list of persons who have been prime ministers of India in the past. We thus give a denotative definition simply by listing all the things or individuals who are members of the class.

A denotative definition can be either verbal or non-verbal (ostensive). A verbal definition is one that linguistically identifies all objects to which the term can be correctly applied by naming them. For example, to give a verbal definition of the term 'planets in the solar system' one can give the names of all the planets that go around the Sun. A verbal denotational definition of 'past presidents of India' will consist of the names of all the past presidents of India. There are, however, several limitations to verbal denotational definitions:

a. It is not always possible to name all the objects denoted by a word or expression. General terms refer to infinite number of things. Terms like 'numbers' and 'instants of time' refer to infinite series. Even terms such as 'chairs' and tables' denote not only chairs and tables now existing all over the world but also those which existed in the past and those which would exist in the future. Even when an expression refers to a finite set of things (such as 'the colleges of Odisha in the year 2003') it is either cumbersome or inconvenient to name all of the things to which the expression refers in order to elucidate the meaning of the expression.

b. Further, most terms do not have names for each and every individual they include within their denotation. For example, all the individual tables that constitute the denotation of the term 'table' do not have names. To provide a verbal denotative definition of 'table' would require providing a list containing the names of all the individual tables. This is an

impracticable and impossible task.

c. In view of these difficulties, one might suggest that although denotative definition by complete enumeration is not possible, one may try instead to provide a denotative definition by offering a few examples. In practice, we generally follow this procedure to elucidate the meaning a term. This is a very useful method in practice. Citing of examples often assist us to understand the meaning of a term. But the important question is: Can we provide the definition of a term by this method?

d. There are some terms for which denotative definition is entirely impossible. The term 'unicorn' has an accepted meaning in our language. 'Unicorns are fictitious' and 'There are no unicorns in the world' are meaningful statements. Thus we do use it to make meaningful statements. Since there are no unicorns in the world, the term lacks any denotation . So although the word 'unicorn' is meaningful we cannot indicate its meaning by this method.

(b) Ostensive Definition :

An ostensive definition is a form of denotative definition. An ostensive definition is given by indicating the individuals, things or events to which the term applies. Ostensive definition explains the meaning of a word or phrase by pointing to what the word or phrase refers to. Ostensive definitions are non-verbal. In an ostensive definition the definiendum is a term but the definiens is an object in the world. Ostensive definitions establish a link between words and objects in the world. It consists in the act of pointing to an example. Suppose you point to a floppy disk lying on the table to explain to someone who does not know what the word "floppy" means. This will be a case of ostensive definition. Consider another example. Suppose that you are inside a zoo with your younger brother who has not seen a kangaroo yet. Pointing to a kangaroo you tell him, "Look, this animal is a kangaroo". These are attempts to explain the meaning of terms by ostensive definitions.

An ostensive definition is

(a) denotative, because the meaning is given by the set of individuals, objects, or events to which the term or expression can be correctly applied;

(b) non-verbal, because the denotation of the term or expression is indicated non-linguistically (e.g., by pointing or displaying);

(c) explicit, because the meaning of the term or expression is given entirely by, and nothing else but, the objects picked out by the act of ostension.

While ostensive definitions are often useful, they do not always work. Since ostensive definitions are denotative definitions, they share the limitations characteristic of denotative definitions. There are several other limitations of ostensive definitions as well. Firstly, while explaining the meaning of a term to someone by pointing to it, the person's attention might get directed to the wrong object. Secondly, even if you succeed in identifying the right object by pointing to it, there remains the possibility that some special feature of the thing will mistakenly get identified in place of the thing itself. Thirdly, the objects to be ostensively defined are not always available. For instance, you cannot ostensively define 'ocean' while in Koraput. Fourthly, the technique of ostensive definition is not suitable for abstract terms such as numbers, the gross national product, or the average worker.

In support of ostensive definitions it can be pointed out that there are cases where denotative definition is the only way we can explain the meaning of a term. In any language there are some words we first learn by pointing at examples to which the term applies. Sensation words refer to relevant sense experiences. There is no other way to make their meaning clear.

(c) Connotative Definition : Definition by Genus and Differentia :

You will recollect that the connotation of a term consists of common and essential attributes shared by all the objects denoted by the term. A connotative definition identifies the meaning of a term by providing a synonymous linguistic expression. A connotative definition is a verbal definition. The definition of 'triangle' as 'a plane figure enclosed by three straight lines' is an example of connotative definition. In such definitions, the word or expression being defined is called the

definiendum, and the expression that states the definition is called the definiens. Thus, in the above example, 'triangle' is the definiendum, while 'a plane figure enclosed by three straight lines' is the definiens. The definiens and the definiendum are synonymous expressions and both have the same meaning.

An effective and popular method of providing connotative definitions for general terms is by stating their genus and differentia. Classical logicians have developed this method in great detail. The basic procedure involved in providing this kind of definition is as follows: we begin by identifying a wider class (the genus) of which the term is a subclass (species); then we specify the distinctive features (the differentia) that set the members of this subclass apart from all the other things belonging to other subclasses within that wider class. Our definition of 'triangle' stated above followed this procedure. We first identified the wider class "enclosed plane figure" as the genus to which all triangles belong and then we specified "bounded by three straight lines" as the differentia that distinguishes the subclass triangles from other closed plane figures like circles, rectangles, pentagons etc. Similarly, the term 'human being' can be defined as 'rational animal' by this method. Human beings belong to a wider class of animals, but are different from other animals by virtue of their rationality. The term 'animal' is the genus of the term 'human' and 'rational' is the differentia that distinguishes members of the human species from the members of other coordinate species belonging to the genus 'animal'. It can be noticed that the terms 'genus' and 'species' are relative terms. A term can be a genus in relation to its subclasses, but a species in relation to another wider class. Thus the class of animals is a genus relative to its subclass humans, but it is a species in relation to the larger class of living things that includes plants as well.

This method of defining terms by stating their genus and differentia has certain limitations. Words signifying elementary qualities like 'red', 'blue' etc. cannot be defined by this genus and differentia method, because these qualities cannot be analysed further into anything simpler. The sensed qualities like 'red' and 'blue' are identified in our experience and the difference among these qualities is also learnt in experience. Since we do not normally know how to express the difference one shade of colour from another, we cannot define these terms by this genus-differentia method. There are unique particulars like 'space' and 'time' which cannot be brought under any

class. So, definition by genus and differentia is not possible in such cases. Further, a universal class which constitutes the highest class cannot be defined by this method. A universal class which is all inclusive would be the summum genus or the highest genus. Terms connoting universal attributes like 'being', 'existent' etc. and words standing for ultimate metaphysical categories like 'substance', attribute, etc. cannot be defined by this method, since these are supposed to designate highest classes and therefore cannot be brought under any higher class.

(d) Rules for Definition by Genus and Differentia:

There are five rules by means of which we can evaluate the success of connotative definitions by genus and differentia:

1. *A definition should state the entire connotation of the term, neither less nor more*. The entire connotation of the term is given by stating the genus and the differntia of the term. If more than the logical connotation is stated, it becomes over complete definition. If less than the entire connotation is stated, it becomes an incomplete definition. For example, the definition of human beings as language-speaking rational animals states more than the connotation. If we define human beings as rational, it would be a case of incomplete definition. Thus when definition states more than the exact connotation there arises the fallacy of overcomplete definition and when definition states less than the entire connotation there arises the fallacy of incomplete definition.

   Further, the connotation of a term consists of the essential attributes of the class. The definition should focus on essential features shared by all and only the members of the class. The things to which a term applies may share many distinctive properties. But all these properties do not indicate the true nature of the term. The definition of "human beings" as "featherless bipeds" is not a good definition even if it picks out the right individuals. Simply by stating a property (that follows from the connotion) or stating an accidental quality of the definiendum definition does not become sound. By stating an additional quality above the connotation (the additional quality may be a property or an accident) the definition becomes overcomplete. If simply a property or an accidental

quality is stated without the connotation the definition becomes in complete. Over complete or incomplete definition is fallacious in nature.

2. *The denotation of the definiendum and the definiens should be identical*. This rule states that the definition of a term should capture the correct denotation of the term. A good definition will apply exactly to the same things as the term being defined, no more and no less. When this rule is violated we have a fallacy of either too broad or too narrow definition. For instance, the definition of "bird" as "warm-blooded animal" will be too broad, since it would include not only birds but also horses, cattle and dogs as well. On the other hand, the definition of "bird" as "feathered egg-laying animal" will be too narrow, since it would exclude male birds. So a good connotative definition must be satisfied by all and only those things that are included in the denotation of the term they define.

3. *A definition should not be circular*. A definition is circular if the *definiendum* turns up in the *definiens*. A circular definition uses the term being defined as part of its own definition. Since the purpose of a definition is to explain the meaning of a term or to make its meaning clear, this purpose is defeated if the term is included in the definition. Someone who does not understand the term will not be benefited by such a definition. "A cordless phone is a telephone that has no cord", "Man is human", "Circles are circular in shape" are examples of circular definition.

4. *A definition should not be expressed in ambiguous, obscure, or figurative language*. While defining a term one should avoid figurative and obscure language. The aim of definition is to explain the meaning of a term to someone who is unfamiliar with its proper application. So the use of ambiguous, obscure, or figurative language will not help such a person learn how to apply the term. Thus, "happiness is a warm puppy" is a good poetic metaphor, but as a definition it will be useless. So too ambiguous definition, figurative definition and obscure definition are fallacious. Scince is knowledge (ambiguous definition). Childhood is the morning of life(figurative definition). Student is a perpendicular homo sapion with neck-tie (obscure definition).

5. *A definition should not be negative where it can be affirmative*. A definition should

state what a term means rather than what it does not mean. A good definition should use positive designations whenever it is possible to do so. The difficulty with negative definition is that there are too many things a term does not signify. For example, a table is not a chair, not a sofa, not a bed, not a house and so on and so forth. Similarly defining "triangle" as "a figure which is not a circle" is a negative definition. It is not possible to explain the application of a term by identifying some of the things to which it does not apply. In a few instances, however, this may be the only way to go. A proper definition of the mathematical term "infinite" might well be negative. Terms having negative content, such as 'blind' or 'opaque', are to be defined negatively. But in ordinary circumstances, it is advisable to offer positive definitions.

SUMMARY

Disputes are of two types – verbal and genuine. Genuine disputes arise when there is a disagreement in belief or disagreement in attitude. Disagreements in belief arise when parties in a dispute have conflicting judgments about the same fact; disagreements in attitude arise when parties in a dispute express different feelings or attitudes towards the same fact. Verbal disputes are not due to any genuine disagreement but are due to the use of ambiguous or excessively vague words. Such disputes can be avoided if one takes care to distinguish between the different meanings of the key words and specify the sense in which one is using the words. Defining the key terms in an argument is a very effective method of avoiding verbal disputes.

A definition states the meaning of a term. The word or phrase we seek to define is called the *definiendum* and the group of words used to state the meaning is called the *definiens*. A definition is either reportive or stipulative. A reportive definition of a term reports the meaning the term already has, so it can be either correct or incorrect. A stipulative definition deliberately assigns a new meaning to the term. It is a proposal or suggestion and not a report. So it is neither true nor false. Corresponding to the two different kinds of meaning (denotation and connotation) of terms, there can be denotative and connotative definitions of terms. Denotative definitions can be either verbal or non-verbal (ostensive). There are several limitations of these different forms of denotative definitions. A connotative definition of a general term states the common and essential attributes shared by all members of the class. Definition by stating the genus and differentia is an effective and popular method of providing connotative definition of a general term. In this form of

definition we first name the genus or higher class of which the term defined is a species or subclass, and then we name the differentia that distinguishes the members of that species from members of all other species coming under that genus. There are five rules for connotative definition or definition by differentia.

1. A definition should state the common and essential attributes of the class. That is it must state the entire connotation of the term, neither more nor less.
2. A definition must capture the entire denotation of the term. It should be neither too broad nor too narrow.
3. A definition must not be circular.
4. A definition should not be expressed in ambiguous, obscure, or figurative language.
5. A definition should not be negative where it can be affirmative.

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MODEL QUESTIONS

I. Choose the option you think to be most appropriate.

1. A disagreement in attitude is a

a. verbal disagreement
b. disagreement in fact
c. genuine disagreement
d. fake disagreement

2. Approvals and disapprovals are expressions of

a. disagreement in attitude
b. agreement in attitude
c. verbal disagreement
d. verbal agreement

3. "Human beings are rational animals." In this definition the term "human beings" is the

a. species.
b. difference.
c. definiendum
d. genus.

4. A mother holds her baby's hand and pronounces the word "hand" in order to teach the baby what the word "hand" means. This is an example of

a. ostensive definition.
b. connotative definition.
c. stipulative definition.
d. verbal definition.

5. "Living things" means plants and animals. This is an attempt to define "living things" by citing its

a. extension.
b. synonym.
c. genus and difference.
d. none of the above.

6. "The term 'months having less than 31 days' refers to February, April, June, September and November." This is an instance of

a. circular definition.
b. connotative definition.
c. denotative definition.
d. explanation

7. A group of words used to define another word or phrase is called the

a. definiens.
b. definiendum.
c. genus
d. species

8. Stipulative definitions are

a. always true.
b. always false.
c. sometimes true and sometimes false.
d. neither true nor false.

9. The terms have been arranged in order of increasing connotation in:

a. living beings, animals, mammals, dogs
b. living beings, mammals, animals, dogs
c. dogs, mammals, animals, living beings
d. dogs, animals, mammals, living beings

10. The terms have been arranged in order of increasing denotation in:

a. animals, mammals, human beings, women
b. women, human beings, mammals, animals
c. mammals, animals, human beings, women
d. human beings, women, animals, mammals

II. Fill in the blanks by choosing the appropriate option from the list given in the bracket.

1. A term is _____ when it has more than one distinct meaning. (ambiguous, vague, precise)
2. A term is _____ when there are borderline cases, such that it is not clear whether the term should be applied to them or not. (ambiguous, vague, transparent)
3. The _____ is a symbol that is being defined. (definiens, definiendum, definition)
4. _____ are employed to eliminate ambiguity and achieve precision. (denotations, definitions, deductions)
5. A genus and differentia definition should state the common and essential _____ of a species. (attributes, examples, references)

6. An _____ definition refers to examples by means of pointing or some other gestures. (essential, ostensive, exemplary)
7. A genus and differentia definition must not be _____, meaning the definiendum must not appear in the definiens. (ambiguous, vague, circular)
8. Disputes arising out of either ambiguity or vagueness are _____ disputes. (verbal, factual, emotional)
9. General terms refer to _____ number of things. (finite, infinite, limited)
10. The definition of "rectangle" as "a plane figure bounded by four straight sides" commits the fallacy of _____ definition. (too wide, too narrow, circular)

III. Suppose that the following are proposed as definitions by genus and differentia. Point out a defect in each case by mentioning the rule that has been violated.

1. "Right" means not wrong.
2. "Evil" is the darkness that lies within the human soul.
3. "Penguin" means bird that can't fly, but is not an ostrich.
4. "Jellyfish" means an animal without a spine.
5. "Square" means a closed plane figure having four right angles.
6. "Wife" means spouse who is not a husband.
7. A triangle is a closed plane figure having three sides of equal length.
8. "Snake" means a widely feared animal that symbolizes evil.
9. "Coward" means a spineless person.
10. "Camel" means ship of the desert.

Essay type questions :

1. Distinguish between verbal and genuine disputes. Explain the role of definitions in eliminating verbal disputes.
2. Explain how the genus and the differentia combine to produce a definition. Point out the common mistakes that occur when rules of this type of definitions are violated.

3. Distinguish between denotative and connotative definitions. Explain the different forms of denotative definitions.
4. State and explain the rules of definition by genus and differentia. Point out the limitations of this kind of definitions.
5. What is an ostensive definition? Point out its usefulness and limitations.
6. Evaluate the following as definitions by genus and differentia.
   (a) Grammar is a branch of philology.
   (b) Virtue is acting virtuously.
   (c) A dog is an animal of the canine species.
   (d) Logic is the art of reasoning.
   (e) Music is an expensive noise.
   (f) Mango is a kind of fruit.
   (g) Life is the opposite of death.
   (h) Man is a featherless biped.
   (i) Man is a rational biped.
   (j) Politeness is the oil that lubricates the wheels of society.

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CHAPTER- 4

CATEGORICAL PROPOSITION

4.1. The Nature of Categorical Proposition :

We have discussed earlier that logic is concerned with arguments. It distinguishes good arguments from the bad ones. An argument consists of propositions out of which one is called the conclusion and others are called premises. We also noticed that arguments are either deductive or inductive. In this book we focus on a system of deductive arguments consisting entirely of categorical propositions. However, in chapter - 8 we develop a logic of truth functions based on a broader notion of proposition. So the notion of proposition is crucial to the notion of argument. Proposition for its definition depends on the notion of term, because proposition is a relation between terms. A term, on the other hand, is a word or a combination of words that can be used either as a subject or a predicate of a given proposition. Hence to understand the notion of proposition we have to understand the notion of term, its relation to words as well as the notion of copula that relates the subject with the predicate in a proposition.

A word consists of a letter or a combination of letters converying some meaning. For example, 'a'and 'I' are words consisting of one letter, and "table", "chair" "students", "mean", "lion" are words consisting of many letters. A combination of words, expressing a complete sense is called a sentence. A sentence belongs to a particular language. It consists of a single word or a combination of words in conformity with the grammatical rules. For example, "Fire!", "Go", "The rose is red" etc. are sentences. First two sentences are one worded sentences and the last one is a sentence consisting of a combination of words. Any arbitrary combination of words cannot be called a sentence. For example, "Going is Ram" is not a sentence though it is a combination of words. In this case grammatical rules are not followed and thus it does not

convey any meaning. By rearranging the words in the above expression we can obtain the expression such as "Ram is going" or "Is Ram going ?" These are grammatically correct sentences. Grammatically, sentences are of different types namely, assertive or declarative sentence (e.g. "The rose is red"); imperative sentence (e.g. "Do not tell a lie"); interrogative sentence (e.g. Has the servant come back ?); optative sentence (e.g. "May you be happy") and exclamatory sentence (e.g. "What a beautiful scenery is this !"). A logician is not interested in all these types of sentences because all these, except the declarative sentence, are not used to assert or deny anything. Logicians are interested only in declarative sentences as they express propositions that are either true or false. Intuitively we may say that what a declarative sentence states or expresses is a proposition.

A categorical proposition consists of three constituents or parts, namely 'subject', 'predicate' and 'copula'. Note that unless otherwise qualified whenever we talk of proposition we shall mean categorical proposition. A proposition always asserts or denies something about something. About whom the proposition states something is called the subject and what it says is called the predicate of the proposition. The word or words that establish the relationship between subject and predicate is called the copula. In other words, the copula of a proposition is a word (e.g. 'am', 'is', 'are') or combination of words (e.g. 'am not', 'is not', 'are not') expressing the relation between subject and predicate. For example, in the proposition 'Crows are black', the word 'crows' is our subject as this proposition is conveying information about crows. The word 'black' is the predicate as it says that 'black' is true of crows. The word "are" relates both subject and predicate and thus "are" is the copula. Proposition is a relation between subject and predicate. The word or the combination of words that can be used either as a subject or as a predicate of a given proposition is called a term. In the above proposition "Crows are black", the word 'crows' is used as subject and the word 'black' is used as predicate. So "crows" and "black" are terms. But the word 'are' is used neither as a subject nor as a predicate and thus is not a term. Its role is to relate both subject and predicate in the above proposition. Hence, it is called copula. The subject term refers to objects about which we are talking and the predicate

term refers to what we are talking about the subject. Diagrammatically, the subject, predicate and copula of the given proposition "Crows are black" can be viewed as follows.

Subject term	Copula	Predicate term
Crows	are	black

Though the proposition contains three elements (subject, predicate and copula) yet all declarative sentences in our everyday use of language may not exhibit all these three elements. For example, "Ram eats" expresses a proposition, where all these above three elements are not explicitly stated. Hence we have to convert the proposition "Ram eats" in such a way (like "Rama is a person who eats") so that all these three items are specified explicitly. For this purpose, it is convenient to identify the copula first. Then we can say what precedes the copula is the subject term and what succeeds the copula is the predicate term. Thus it is necessary to reflect on the nature of copula.

4.2 Nature of Copula :

The copula expresses the relation between the subject term and the predicate term. In this context, two questions can be raised relating to the notion of copula, viz. (i) what would be the form of copula ? (ii) should the sign of denial be attached to the copula ?

Of course, the copula of a proposition, being different from the subject as well as the predicate, is expressed by the verb of the sentence. Thus, the verb takes the burden of expressing the notion of copula. But in general, it cannot be said that the copula is just the verb of the sentence. Because, there are sentences where the same word acts both as a verb as well as the predicate. For example, consider the proposition 'Ram eats'. Here 'Ram' is the subject but the predicate of this sentence has merged with the copula in such a way that we cannot identify the copula of the proposition. Thus, we have to be clear about the form of the verb expressing the copula. On the other hand, if we allow the merger of the copula with the predicate, i.e. if we say

the word 'eats' in the proposition "Ram eats" is both the predicate and also the copula then we are actually assigning a function to the copula for which it is not capable of. The verbs such as 'laugh', 'walk', 'eat', 'drink', 'run' etc describe some activity of the subject and thereby convey some information about the subject. For this reason such verbs satisfy the definition of predicate (predicate gives the information about the subject) but they cannot act as a copula. Because the only function of the copula is to express the relation between subject and predicate, it should not convey any information regarding the subject. So, the idea of merging the copula with the predicate is inconsistent with the role of copula in a proposition. Thus, it is necessary to separate the copula from the predicate and at the same time, the copula should be capable of expressing the relation between subject and predicate in a proposition. To achieve this purpose, the verb 'to be' alone is capable. Therefore, the copula of a proposition must be expressed by the verb 'to be'. Further, there can be questions with respect to the tense of the copula. What would be the tense of the copula? Regarding this, it may be said that the copula must be always in present tense because of the following reason. As we know, the copula unites (or expresses the relation between) subject and predicate. The copula, being the particle to express a relation between subject and predicate term in a proposition, must be in the present tense. Otherwise, it is impossible to assert the existence of a relation between subject and predicate. Because, for any subject term 'S' and any predicate term 'P', if S was P (i.e. assuming the copula in past tense), one has to presuppose that 'S' and 'P' were related in past but at present the relation between them may be absent. Hence, the copula cannot be in past tense. By use of an analogous reasoning, it can also be shown that copula cannot be in future tense. So, the copula must be in present tense, otherwise the assertion or denial of a relation would be impossible. Thus, the copula of a proposition admits the present tense of the verb 'to be'.

As to the second question (should the sign of denial be attach to the copula?) our answer would be "yes". The sign of negation will be a part of the copula. The reasons for this are as follows. Given any proposition, either the predicate is affirmed of the subject (as in case of "Ram is honest") or it is denied of the subject (as in case of "Ram is not honest"). The former yields an affirmative proposition, whereas the latter yields a negative proposition. In case of a negative

proposition our problem is to decide whether we should attach the sign of negation to the copula or to the predicate. For example, how are we to form the negation of the proposition 'Ram is honest'? Should we say "Ram is not honest" or "Ram is not-honest"? If we say the particle 'not' should be attached to the predicate and not to the copula then we are presupposing that copula must always be in affirmative. This means there can't be any negative relation possible between the subject and predicate. In other words, there cannot be any negative proposition to be found in our language. This implies that all propositions are affirmative. This is clearly false. Hence, by attaching the sign of negation to the copula, we are accepting the existence of negative relation. Further, copula only being a particle for expressing the relation between subject and predicate term of a proposition, should express both affirmative and negative relation. For this, the sign of negation should be attached to the copula. Moreover, if we allow that the sign of negation to be attached to the predicate and not to the copula then we are really allowing the predicate to express the negative relation for which predicates are unfit.

From these considerations we follow the convention that the copula will admit only present tense of the verb 'to be' and the sign of negation will be attached to the copula and not to the predicate. Hence, the form of the copula would be either 'am' or 'am not', 'is' or 'is not', or 'are' or 'are not' and nothing else.

4.3 Classifications of Propositions :

We have already discussed the notion of proposition as a relation between subject and predicate terms. Now we may proceed to discuss the classification of propositions. Propositions may be classified into various classes according to different principles, such as the principles of composition, relation, quality, quantity, modality, significance etc. But for our purpose it suffices to consider the classification of propositions according to relation, significance, quality, quantity and both quality and quantity.

(a) Classification of propositions according to relation : According to relation, propositions are of two types namely (i) categorical and (ii) conditional. This distinction depends on the nature of the relation between subject and predicate of the proposition. A proposition is

called categorical if the relation between subject and predicate of the propostition is either affirmed or denied without any condition or restriction. In other words, a categorical proposition is one in which the predicate is either affirmed or denied of the subject unconditionally. For example, "All men are mortal", "Some men are rich", "Gopal is the author of many books" are propositions in which the predicate is affirmed of the subject without any condition. So, they are all categorical propositions. Similarly, "No man is perfect", Some men are not rich", "Gopal is not the son of Ram" are propositions in which the predicate is denied of the subject without any condition. Hence, they too are categorical propositions.

On the other hand, in case of conditional propositions, the relation between subject and pedicate holds conditionally. It is of three types, namely (i) Hypothetical, (ii) Alternative and (iii) Disjunctive. A hypothetical proposition is a conditional proposition, having the form "if P then Q", where "P" and "Q" stand for any propositions. In this case, the "if-clause" and "then-clause" of the proposition are respectively called antecedent and consequent. The antecedent (or the if-clause) always states the condition for asserting the consequent (or the then-clause), For example, "I shall go if he comes", here "he comes" is the antecedent and 'I shall go' is the consequent of the above proposition. Moreover, since "my going" depends on "his coming", "I shall go if he comes" is a hypothetical proposition. The same is the case with the propositions "I shall not go to the college if it is raining". Here "my not going to the college" depends on "raining". So "it is raining" is the antecedent and "I shall not go to the college" is the consequent.

An alternative proposition is a kind of conditional proposition having the form "either P or Q", where P and Q are called alternatives representing propositions. In this case, we cannot assert or deny both the alternatives. The assertion of one of them depends on the denial of the other and vice-versa. For example, "Either he is a vegetarian or a non-vegiterian", "Either he is alive or dead". Here both the alternatives cannot be asserted or denied simulataneously. The affirmation of one alternative implies the denial pf other alternative and the

denial of one alternative implies the assertion of the other alternative.

A disjunctive proposition is a kind of conditional proposition having the form "either P or Q", where P and Q are called disjuncts, representing propositions. In this case, we cannot deny both the disjuncts, though both of them can be asserted. A disjunctive proposition holds good even if one of its disjuncts is asserted. For example, consider the proposition, either Ashok does *yoga* or *pranayam*. The proposition is false if Ashok does not do either of the two. But there is no harm if he does both. In other words, a disjunctive proposition holds good if one of its disjuncts is asserted and false if both are denied. So in a disjunctive proposition the denial of one disjunct implies the assertion of the other disjunct but the assertion of one disjunct does not entail anything. For both the disjuncts can be true together, but cannot be false together.

Though propositions according to relation are divided into categorical and conditional yet the ancient logicians, including Aristotle, were interested only with categorical propositions. This is because, any conditional proposition is built out of categorical propositions by use of propositional operations like "If .....then", either ..... or ....." etc. Hence, categorical proposition is the most basic type of proposition and we shall now develop a system of deductive logic based on the notion of categorical proposition.

(b) Classification of Propositions according to significance : According to significance, a proposition is either analytic (or verbal) or synthetic (or real). We know that a proposition (or more precisely a categorical proposition) expresses a relation between subject and predicate terms. A proposition is called analytic (or verbal) if and only if either the subject and predicate terms are equivalent in meaning or the predicate states part of the meaning (or connotation) of the subject. In other words, an analytic proposition is one in which the predicate is either partially or wholly contained in the subject. The truth or falsity of such propositions depends entirely on the meaning of the subject as well as the predicate term occurring in the proposition. For example, "Triangle is a plane figure bounded by three straight lines," "All bachelors are unmarried", "All circular figures are figures", "All red things are coloured",

"Black cats are black" are examples of analytic proposition. The truth of such a proposition depends on the meaning of the subject, predicate and copula present in the proposition. Thus, to accept or reject such a proposition we don't have to see how the things really are in the world but only to know the meaning of the words and terms prsent in it. Thus to know the truth of "All bachelors are unmarried", we don't have to look at the world to see whether a bachelor is unmarried or not. If we know the meaning of terms ('all', 'bachelor', and "unmarried") and the copula (is) then we would be in a position to ascertain its truth.

On the contrary, a proposition is called synthetic (or real) if and only if its truth or falsehood depends on facts. In case of synthetic proposition the subject and predicate terms are non-equivalent in meaning. In such a case, the predicate states something new about the subject in the sense that the predicate is not contained either implicitly or explicitly in the subject. To know the truth of synthetic proposition say "It is raining", "The grass is green", "All men are mortal", we have to look at the world to see how the things really are. Without looking at the world, we cannot either reject or accept the truth of a synthetic proposition.

An analytic proposition is necessarily true as it is independent of facts. The opposite or negation of an analytical proposition is necessarily false as it is self-contradictory.

On the contrary a sythetic proposition is true or false as a matter of fact. The opposite of a synthetic proposition is also a synthetic proposition. It may be false but never self-contradictory.

(c) Classification of propositions according to quality : According to quality, a proposition is either affirmative or negative. A proposition is called affirmative if and only if the predicate is affirmed of the subject. For example, in the proposition "Ram is a boy", the predicate 'a boy' is affirmed of the subject "Ram". A proposition is called negative if and only if the predicate is denied of the subject. For example, in the proposition "Ram is not rich" the predicate 'rich' is denied of the subject. In case of affirmative proposition, the copula is affirmative whereas in negative propositions the copula carries

the sign of negation. But in case of universal negative propositions, the sign of negation is not attached to the copula but to the subject. For example in "No man is perfect' or 'No S is P', the sign of negation is attached to the subject of the proposition. However, this is mere a convention of English language. Note that the quality of the hypothetical proposition depends on the quality of the consequent. For example, the negation of "If he comes, I shall go' would be 'If he comes, I shall not go'. Similarly the negation of 'if A is B then C is D' would be 'if A is B then C is not D. Briefly, we may say that if the consequent of a hypothetical proposition is negative (or affirmative), the hypothetical proposition in question is negative (or affirmative). To repeat, the quality of a hypothetical proposition depends on the quality of the consequent.

(d) Classification of proposition according to quantity : According to quantity a proposition is either universal or particular. A proposition is called universal if the predicate of the proposition is either affirmed or denied of the entire denotation of the subject. On the other hand, a proposition is called particular if the predicate of the proposition is affirmed or denied of a part of the denotation of the subject. For example, in the proposition "All men are mortal", the predicate 'mortal' is affirmed of the entire denotation of the subject. Here the word 'all' refers to the entire denotation of the subject term 'man'. Similarly, in the proposition "Some men are rich", the predicate 'rich' is affirmed of a part of the denotation of the subject term 'men'. Further, in the proposition "Some men are not rich" the predicate term 'rich' is denied of a part of the denotation of the subject term. In "No man is perfect" the predicate term is denied of the entire denotation of the subject. Thus the words like 'All', 'No', 'Some' etc are quantity-words specifying the quantity of the term to which it is attached. 'All' and 'No' are marks of universality and the word 'some' indicates particularity. In a logical proposition the quantity - words (or the quantifiers) are attached only to the subject term. According, "All men are mortal", "No men is perfect" are

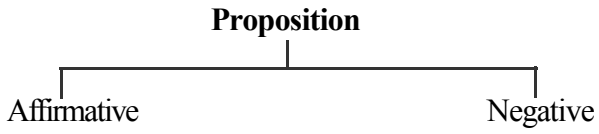
examples of universal proposition where as "Some men are rich", "Some men are not rich" are examples of particular propositions.

Note that the classification of propositions that we have introduced so far is mutually exclusive and taken it jointly are exhaustive. For example, the division of proposition according to quality is either affirmative or negative. This division is mutually exclusive because it is impossible to find a proposition, which is both affirmative as well as negative. In other words, if a proposition is affirmative then it cannot be negative and vice versa. Similarly, this division is also exhaustive, which means that there is no proposition which is neither affirmative nor negative. These two conditions jointly say that any proposition must have exactly one quality i.e. either it is affirmative or negative. The same is the case with other divisions of propositions like division according to relation and division according to quantity.

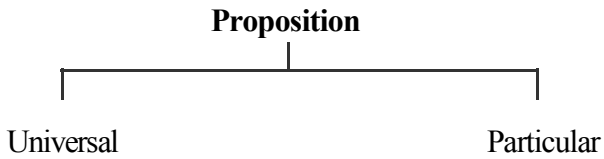
(e) Classification of propositions according to both quality and quantity :

We have already discussed the classifications of propositions according to quality as well as quaintity, that may be repeated for convenience. According to quality, the propositions are of two types i.e. affirmative and negative and according to quantity, propositions are universal and particular. From these two classifications, we obtain a thrid type of classification of propositions according to the mixed principle of quality and quantity. This may be explained as given below:

According to quality

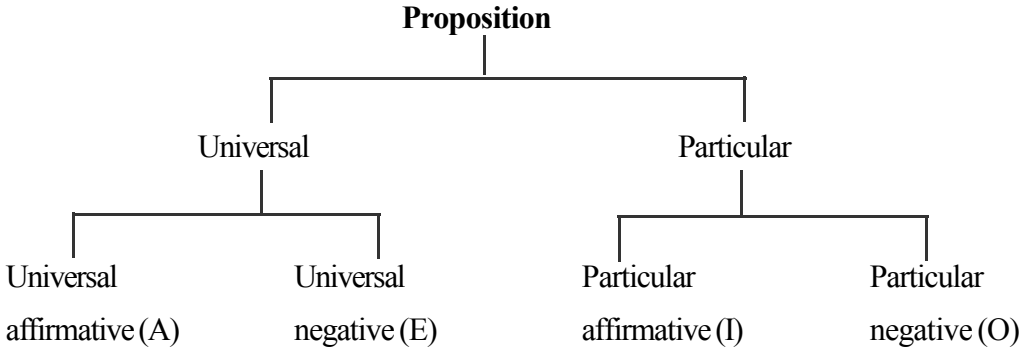


According to quantity



Now if we combine these two types of classifications, we obtain a new division of propositions. Accordingly any universal proposition is either affirmation or negative; so also any particular proposition is either affirmative or negative. Thus we have four types of propositions in all namely, universal affirmative, universal negative, particular affirmative and particular negative. This may be stated by use of a classificatory table as given below:

According to the mixed principles of quality and quantity,



Popularly these four types of propositions are respectively known as A, E, I and O propositions. For example, "All men are mortal" is an A-proposition or universal affirmative proposition. It is a universal proposition because the predicate term 'mortal' is affirmed of the entire denotation of the subject term. It is also affirmative as the predicate is affirmed of the subject. Thus, for an A-proposition we have to verify two conditions i.e. firstly the predicate must be affirmed of the subject and secondly, it must be affirmed of the entire denotation of the subject. The structure of A-proposition is 'All S is P' where 'S' and 'P' stand for subject term and predicate term respectively.

Universal negative propositions are called E-propositions. 'No man is perfect' is an example of an E-proposition. In this case the predicate term 'perfect' is denied of the entire denotation of the subject term 'man'. Since it is a case of denial of the predicate, it is negative and since the denial is about the entire denotation of the subject, it is universal. Hence, the proposition "No man is perfect" is an example of universal negative proposition or E-proposition. It has the form "No S is P", where 'S' and 'P' stand for the subject and predicate terms respectively.

"Some men are rich" and "Some men are not rich" are examples of I and O-propositions respectively. In the case of former the predicate term 'rich' is affirmed of a part of the denotation of the subject, whereas in case of the latter the predicate term is denied of the part of the denotation of subject. Hence, the former is particular affirmative and the latter is particular negative. The structures of I and O-propositions respectively are "Some S is P" and 'Some S is not P', where 'S' and 'P' stand for subject and predicate terms. For our convenience we may summarise above discussion in the following table.

Types of Proposition	logical name	Structure	Concrete example.
Universal Affirmative	A-Proposition	All S is P	All men are mortal.
Universal Negative	E-proposition	No S is P	No man is perfect.
Particular Affirmative	I-proposition	Some S is P	Some men are rich.
Particular Negative	O-proposition	Some S is not P	Some men are not rich.

Note that for Aristotle these four types of categorical propositions (such as A,E,I and O-propositions) are called logical propositions because they exhibit two essential or unavoidable features namely quality and quantity.

Further, a categorical proposition in which logicians are interested exhibits its logical constituents explicitly. It states its quantity, quality, subject and predicate in an explicit manner. These four constituents in a categorical proposition should be written in the following order. quantifier, subject term, copula (exhibitting the quality of the proposition) and predicate term. The cateogircal proposition where all these constituents are specified is called a logical proposition. The general schema or the skeleton of a logical proposition is as follows :

Quantifier	**Subject term**	**Copula**	**Predicate term**

Words such as "all" "none" and 'some' are quantifiers which express universality and particularity. Here we may note that quantifiers are attached only to the subject of a categorical proposition. Moreover, A, E, I and O-propositions are recognised as the most basic for Aristotle

because for him any proposition in our ordinary language may be reduced to either of these above four forms without any change of meaning. Thus, our next section is devoted to deal with the method of reduction of propositions into their logical or standard form.

4.4 Reduction of Propositions into Logical Form :

We have seen that there can be four standard forms of categorical propositions such as A, E, I and O-propositions having the structure of the form, 'All S is P' 'No S is P', 'Some S is P' and 'Some S is not P' respectively. Thus, we know that the logical structure of any categorical proposition exhibits the following four items in the order as given below.

Quantifier (Subject term) copula (predicate term)

Here the first item is the 'quantifier' (or more precisely the words expressing the quantity of the proposition). It is attached to the subject term only. The second item in any logical proposition is the subject term. The predicate term, that expresses something about the subject, comes after the copula. The copula is placed in between the subject and predicate term. Further, the quality of the proposition is expressed in and through the copula. The copula and the predicate term are respectively the third and fourth logical elements of a categorical proposition. Thus, a categorical proposition which is in standard form must exhibit explicitly the subject, the predicate, the copula, its quality and quanitity. Let us call a categorical proposition regular if it is in its standard form, otherwise it is called irregular. In our ordinary language most of the categorical propositions are irregular in nature. Even though there are irregular categorical propositions they can be put in their regular form. It should be noted that while reducing an irregular categorical proposition into its standard form, we should pay enough attention to the meaning of the proposition so that the reduced proposition is equivalent in meaning to its irregular counterpart.

Before describing the method of reduction of irregular propositions into their regular forms, it is profitable to understand the reasons for irregularity of a categorical proposition. The irregularity of any categorical proposition may be due to one or more of these following factors.

(i) The copula is not explicity stated, rather it is mixed with the main verb which forms the part of the predicate

(ii) Though the logical ingredients of a categorical proposition are present in the sentence yet are not arranged in their proper logical order.

(iii) The quantity of a categorical proposition is not expressed by a proper word like 'all', 'no' (or none), 'some' or it does not contain any word to indicate the quantity of the proposition.

(iv) All exclusive, exceptive and interrogative propositions are clearly irregular.

(v) The quality of the proposition is not specified by attaching the sign of negation to the copula.

Keeping these factors in mind, let us describe systematically the method of reduction of an irregular categorical proposition into its standard form (or into a regular proposition). Below we describe the method of reduction.

I. *Reduction of categorical propositions whose copula is not stated explicitly*

In our ordinary use of language, very often the copula, is not explicitly or separately expressed but is mixed with the main verb. The main verb in such a case, forms the part of the predicate. The moment copula is identified, the other items of a logical proposition are brought out in a usual manner. We know that the copula of any logical proposition must be in present tense of the verb "to be" with or without the sign of negation. Now let us consider an example of an irregular proposition, where the copula is not explicitly stated. "All sincere students deserve success". This is an irregular proposition, as the copula is clearly mixed with the main verb of the proposition. The method of reducing such irregular sentences into regular ones is as follows. The subject and the quantifier of the irregular proposition should remain as they are, while the rest of the proposition may be converted to a class forming property (i.e. term) which would be our logical predicate.

In our above example 'All' is the quantifier attached to the subject 'sincere students'. We should not touch the quantifier nor the subject term of the proposition, they should remain where they are. On the other hand, the rest of the proposition 'deserve success' should be converted into a class forming property 'success deserving'. This should be our logical predicate. Then we link the subject term with the predicate term with a standard copula. Thus,

"All sincere student deserve success." Irregular proposition.

"All sincere students are success deserving." A - proposition.

"All people seek power." Irregular proposition.

"All people are power seekers." A - proposition.

"Some people drink Coca Cola." Irregular proposition.

"Some people are Coca Cola drinkers." I - proposition

II. *Irregular propositions where the usual logical ingredients are all present but are not arranged in their logical order.*

Consider the following examples of irregular propositions. "All is well that ends well" and "Ladies are all affectionate." In these cases, first we have to locate the subject term and then rearrange the words occurring in the proposition to obtain the regular categorical proposition. Such reductions are usually quite straightfoward. Thus we reduce the above two examples as given below.

"All is well that ends well." Irregular proposition

"All things that end well are things that are well." A - proposition

"Ladies are all affectionate." Irregular proposition

"All ladies are affectionate." A - proposition

III *Statements in which the quantity is not expressed by proper quantity words.* Some propositions do not contain word like 'All', 'No', 'Some' or contain no words to indicate the quantity. We reduce such a type of irregular proposition into its logical form as explained below.

Here we have to consider two sub-cases : sub-case (i) where there is indication of quantity but no proper quantity words like 'All', 'No', or 'Some' are used and Sub-case (ii) where the irregular proposition contains no word to indicate its quantity.

Sub-case (i) : Affirmative sentences that begin with words like 'every', 'any', 'each' are to be treated as A-propositions, where such words are to be replaced by the word "all" and rest of the proposition remains as it is or may be modified as necessary. The followings are some of the examples of this type.

"Every man is liable to commit mistakes." Irregular proposition.
"All men are persons who are liable to commit mistakes." A - proposition.
"Each student took part in the competition." Irregular proposition.
"All students are persons who took part in the competition." A - proposition.
"Any one of my students is laborious." Irregular proposition.
"All my students are labourious." A - proposition.

A negative sentence that begins with a word like 'every', 'any', 'each', or 'all' is to be treated as an O-proposition. Any such proposition may be reduced to its logical form as shown below.

"Every man is not honest". Irregular proposition

"Some men are not honest." O - proposition

"Any student cannot get first class." Irregular proposition.

"Some students are not persons who can get first class." O - proposition.

"All is not gold that glitters." Irregular proposition.

"Some things that glitter are not gold." O - proposition.

Sub- Case (ii):

"Sentences with singular term or definite singular term without the sign of negation are to be treated as A-proposition. For example, "Ram is mortal.", "The oldest university of Orissa is in Bhubaneswar." are A-propositions.

Here the predicate is affirmed of the whole of the subject term. On the other hand, sentences with singular term or definite singular term with the a sign of negation are to be treated as E-propositions. For example, "Ram is not a student" and "The tallest student of the class is not a singer" are to be treated as E-propositions. These are cases where the predicate is denied of the whole of the subject term.

IV *"Sentences beginning with the words like 'no', 'never', 'none' are to be treated as E-propositions. The following sentence is an example of this type.*

"Never men are perfect." Irregular proposition

"No man is perfect." E - proposition

V *Affirmative sentences with words, like 'a few', 'certain', 'most', 'many' are to be treated as I-propositions, while negative sentences with these words are to be treated as O-propositions*. Since the word 'few' has a negative sense, an affirmative sentence beginning with the word 'few' is negative in quality. A negative sentence beginning with the word 'few' is affirmative in quality because it involves a double negation that amounts to affirmation. The following are examples of above type.

"A few men are present." Irregular proposition.

"Some men are present." I - proposition.

"Certain books are good." Irregular proposition.

"Some books are good." I - proposition.

"Most of the students are laborious." Iregular proposition.

"Some students are laborious." I - proposition.

Here we may note that 'most' means less than 'all' and hence it is equivalent to 'some'.

"Many Indians are religious." Irregular proposition.

"Some Indians are religious." I - proposition.

"Certain books are not readable." Irregular proposition

"Some books are not readable." O - proposition

"Most of the students are not rich." Irregular proposition.

"Some students are not rich." O - proposition

"Few men are above temptation." Irregular proposition

"Some men are not above temptation." O - proposition

"Few men are not selfish." Irregular proposition

"Some men are selfish." I

VI *Any statement whose subject is qualified with words like 'only', 'alone', 'none but', or 'no one else but' is called an exclusive proposition.* This is so called because the term qualified by any such word applies exclusively to the other term. In such cases the quantity of the proposition is not explicitly stated. The propositions beginning with words like 'only', 'alone', 'none but' etc are to be reduced to their logical form by the following procedure. First interchange the subject and the predicate, and then replace the words like 'only', 'alone' etc with 'all'. For example,

"Only Oriyas are students of this college." Irregular proposition.

"All students of this college are oriyas." A - proposition.

"The honest alone wins the confidence of people." Irregular Proposition.

"All persons who win the confidence of people are honest." A-proposition.

VII *Propositions in which the predicate is affirmed or denied of the whole subject with some exception is called an exceptive proposition.* An exceptive proposition may be

definite or indefinite. If the exception is definitely specified as in case of "All metals except mercury are solid" then the proposition is to be treated as universal and if the exception is indefinite, as in case of "All metals except one is solid", the proposition is to be treated as particular.

"All metals except mercury are solid." is a universal proposition which means "All non-mercury metals are solid."

Now let us consider an example where the exception is indefinite. For example, "All students of my class except a few are well prepared", It is to be reduced to an I-proposition as given below.

"All students of my class except a few are well prepared." Irregular proposition.

"Some students of my class are well prepared." I - proposition.

VIII. *There are impersonal propositions where the quantity is not specified.* Consider for example, "It is cold", "It is ten O'clock". In such cases propositions in question are to be reduced to A-proposition because the subject in each of these cases is a definite description.

"It is cold". Irregular proposition

"The wheather is cold." A - proposition.

"It is ten O'clock." Irregular proposition.

"The time is ten O'clock." A - proposition.

There are some propositions where the quantity is not specified. In such cases we have to examine the context of its use to decide the quantity. For example, consider following sentences (1) "Dogs are carnivorous", (2) "Men are mortal", (3) "Students are present." In first two examples, the quantity has to be universal but in the third case, it is particular. Thus, their reduction into logical form are as follows.

"Dogs are carnivorous." Irregular proposition.

"All dogs are carnivorous." A - proposition.

This is so because we know that "being carnivorous' is true of all dogs.

"Men are mortal." Irregular proposition.

"All men are mortal." A - proposition

Here 'being mortal' is generally true of men. But in the proposition "Students are present", we mean to assert that some students are present". So the proposition "Men are mortal" is reduced to "All men are mortal" But in the example "Students are present", 'being present' is not generally true of all students. So the proposition "Students are present" is reduced to "Some students are present" which is an I-proposition. Thus the context of use of a proposition determines the nature of the proposition.

IX *Problematic propositions are particular in meaning*. For example "The poor may be happy" should be treated as a particular proposition, because what such a proposition asserts is that it is sometimes true and sometimes false. Thus, "The poor may be happy" is reduced to "Some poor people are happy", which is an I-proposition

X *Similarly, there are propositions where the quantity is not specified but their predicates are qualified by the words like 'hardly', 'scarcely', 'seldom'*. Such propositions should be treated as particular negative. For example, "Businessmen are seldom honest", is an irregular proposition. It is reduced to "Some businessmen are not honest". If such a proposition contains the sign of negation, that these proposition is to be treated as an I-proposition. For example, "Businessmen are not seldom honest." is to be reduced to "Some businessmen are honest", which is an I - proposition. This is so because it involves a double negation which is equivalent to affirmation.

4.5 Distribution of Terms :

We have already discussed that there are four types of propositions, namely (i) Universal affirmative (or A-proposition) (ii) Universal negative (or E-proposition), (iii) Particular affirmative

(or I-proposition) and (iv) Particular negative (or O-proposition). Only these types of propositions can occur in any logical argument. Of course, each proposition, in addition to quantifier and copula, must have a subject term and a predicate term. Now we wish to explain a crucial notion viz. 'distribution of terms' in a logical proposition, that plays an important role in developing rules for deductive arguments.

In categorical proposition, terms designate classes of objects. In other words, the subject and predicate terms in a categorical proposition designate classes of objects, and the categorical proposition may be regarded as about these classes. For example, the proposition "All men are mortal" is about the class of men and the class of mortal beings. More over, it is about all men since we are talking about all the members of the class designated by the term, 'men'. On the other hand, in asserting the proposition "All men are mortal", we are not asserting or talking about all the members of the class designated by the predicate term 'mortal'. Hence, only a part of the class of objects designated by the term 'mortal' is being considered. So, in any categorical proposition we may refer to either all or some members of a class designated by a term. To express this insight, Aristotle introduces a technical term called 'distribution'. A term is said to be distributed in a proposition if and only if it refers to the whole of the class designated by the term. Otherwise, the term is called undistributed. If a term refers to a part of the class designated by the term, it is called undistributed. Alternatively, we may say that if a term refers to the entire denotation of a term (or refers to all the members of the class designated by the term) either affirmatively or negatively, then the term in question is distributed. On the other hand, if only a part of a denotation is being referred to by the term then it is called undistributed.

Let us examine which term is distributed in which type of proposition. As we know, there are four types of categorical proposition namely A, E, I and O-propositions. For convenience, let us state the logical form or the structure along with a concrete example of each of the four types of proposition in a tabular form.

Proposition	Logical form	Concrete example
A	All S is P	All men are mortal
E	No S is P	No man is perfect
I	Some S is P	Some men are rich
O	Some S is not P	Some men are not rich

Here the variables S and P are called term variables (i.e. the terms are only to be substituted for S and P). More precisely, 'S' and 'P' stand for subject and predicate terms respectively.

A-Proposition (All S is P)

An A-proposition is a universal affirmative proposition that has the logical structure of the form "All S is P". It is clear that the subject term 'S' in an A-proposition is distributed. Because, here we are considering the entire denotation of the term S. Consider a concrete example, 'All men are mortal'. Here we are asserting that every member of the class designated by the term 'men' is mortal. Hence this statement is about 'all men'. So, according to the definition of distribution, the term 'men' is distributed. On the other hand, the term 'mortal' in our example "All men are mortal" is undistributed as we are not saying anything about the entire denotation of the term 'mortal' in the proposition, 'All men are mortal'. Hence, in this case at best a part of the denotation of the term 'mortal' is being considered. So the predicate term in an A-proposition is undistributed. In sum, in an A-Proposition the subject term is distributed and predicate term is undistributed.

E-Proposition (No S is P)

An E-proposition, otherwise known as universal negative proposition, has the logical structure 'No S is P', where 'S' and 'P' stand for subject and predicate term respectively. 'No man is perfect' is an instance of it. To assert 'No S is P', one is implying that S and P have no member in common, i.e., S and P are excluded from each other, In other words, no member of S is in P and no member of P is in S. Hence, here we are considering the whole of S as well as

whole of P negatively. Hence, both S and P in an E-proposition are distributed. Thus, both the subject and the predicate terms of an E-proposition are distributed.

I-Proposition (Some S is P)

An I-proposition, is a particular affirmative propositions. It has the logical structure or form. "Some S is P". Here both "S" and "P" are undistributed because in asserting 'Some S is P' (or "Some men are rich"), we are not talking of the entire denotation of term 'S' or 'P' (or 'man' and 'rich'). Thus, we are considering a part of the denotation of S and P. Hence, the subject and predicate terms in an I-proposition are undistributed.

O-Proposition (Some S is not P)

An O-propositionis a particular negative proposition that has the logical structure or form, 'Some S is not P'. Here clearly 'S' (the subject term) is undistributed as we are considering some S i.e. a part of the class designated by the term S. The predicate term P is denied of "some S". When we deny a term we deny the entire class designated by the term, otherwise the denial or negation has no meaning. Hence, the predicate term in an O-proposition is distributed as the class designated by 'P' as a whole is being denied of "some S". Thus, in an O-proposition, the subject term is undistributed and predicate term is distributed.

Now we may summarise our above discussion on distribution in a tabular from as given below.

Distribution of Terms

Proposition	Logical form	Subject	Predicate
A	All S is P	Distributed	Unistributed
E	No S is P	Distributed	Distributes
I	Some S is P	Undistributed	Undistributed
O	Some S is notP	Undistributed	Distributed

From this table we may note the following facts with respect to distribution of terms in standard categorical proposition.

(i) In universal proposition, the subject term is distributed whereas in particular proposition subject term is undistributed.

(ii). In negative proposition the predicate term is distributed while in an affirmative proposition the predicate term remains undistributed.

4.6 Seven Fold Relations Between Propositions :

There are seven types of possible relation between propositions. Any two propositions will be related in either of the seven ways. These relations are (i) Independence, (ii) Equivalence, (iii) Contradictory, (iv) Contrary, (v) Sub-contrary, (vi) Sub-altern and (vii) Super-altern. Let us discuss each of these.

(i) Independence

Let P and Q be any two propositions such that neither the truth or falsity of P implies the truth or falsity of Q nor the truth or falsity of Q implies the truth or falsity of P. Then P and Q are called independent. The relation in this case is called independence. For example, "All men are mortal' and "All horses are animal" are clearly independent propositions as any one of them does not imply the other. From the truth or falsity of one, the truth or falsity of the other cannot be inferred. We may note that in a valid deductive argument the conclusion cannot be independent of the premise or premises.

(ii) Equivalence

Two propositions. P and Q are equivalent when they are so related that if P is true then Q is true and if Q is true then P is true; and if P is false, Q is false and if Q is false the P is false.If P and Q are equivalent propositions then it is impossible for P to be true and Q to be false or Q to be true and P to be false. For example, "No men are perfect" and "No perfect beings are men" are clearly equivalent to each other. The relation is called the relation of equivalence.

(iii) Contradictory

Two propositions are contradictorily related if the truth of one implies the falsity of the other and the falsity of one implies the truth of the other. In other words, P and Q are contradictorily related if and only if (i) the truth of P imlies the falsity of Q and conversely and (ii) the falsity of P implies the truth of Q and conversely. Thus two contradictorily related propositions can neither be true together nor they can be false together. For example, "He is alive" and "He is not alive." are contradictorily related. A proposition and its negation are contradictorily related."All Indians are poor".and "Some Indians are not poor". are contradictory to each other. So too "No teacher is rich". and "Some teachers are rich". are contradictory to each other.

(iv) Contrary relation (or contrariety)

Two propositions are contrarily related if the truth of one implies the falsity of the other but the falsity of one does not imply the truth of the other. Here both the propositions can be simultaneously false but they cannot be simultaneously true. 'All S is P' and 'No S is P' are contraries. Thus A and E-propositions with the same subject and same predicate are contrarily related. Here from the falsity of one we cannot derive the truth or falsity of the other.

(v) Sub-contrary relation (or Sub-Contrariety)

Two propositions are sub-contrarily related if and only if the falsity of any one of them imlies the truth of the other but not conversely. Here both the propositions can be true together but they cannot be simultaneously false. For example, "Some men are rich" and "Some men are not rich" can be simultaneously true but they cannot be simultaneously false. The falsity of one implies the truth of the other. Note that in case of contrary relation the truth of any one of the propositions implies the falsity of the other where as in case of sub-contrartry relation the falsity of any one of the propositions implies the truth of the other. Further, for any proposition P and Q if P is contrarily related to Q then from the falisty of P or Q nothing can be infered with respect to the truth or falsity of the other.

(vi) Superalternation

Two propositions P and Q may be related in such a manner, that if P is true then Q is true but P is false then Q remains undecided. Then this relation is called super-alternation and P is

superaltern to Q. This relation holds between A and I proposition and E and O proposition with the same subject and same predicate.

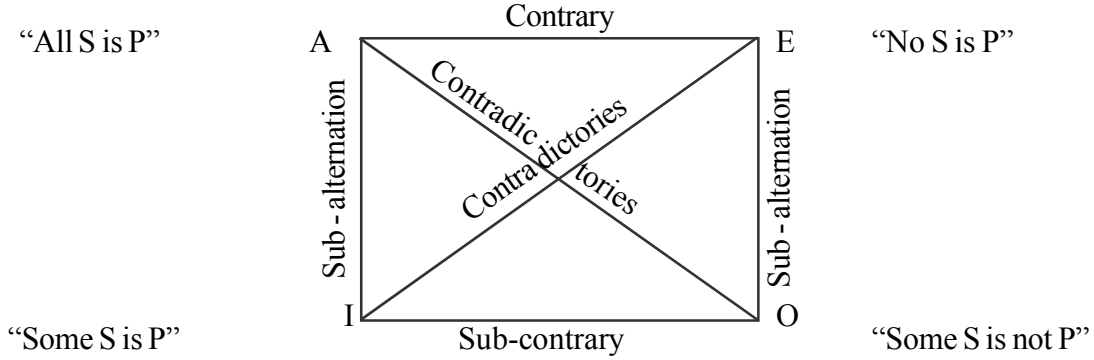
(vii) Subalternation

Two propositions P and Q may be related in such a manner that if Q is false then P is false, but if Q is true then P remains undecided. This relation is called subalternation. Here Q is called subaltern to P. This relation holds between I and A proposition and also between O and E proposition with the same subject and same predicate. Here I-proposition is called subaltern to A-proposition and similarly, O-proposition in the subaltern to E-proposition.

4.7 The Square of Opposition of Propositions :

As we have seen that there are four types of categorical propositions namely A, E, I and O-propositions having respectively the logical structure of the form "All S is P", "No S is P", "Some S is P" and "Some S is not P". Since our main goal is to develop a theory of inference involving these propositions, it is necessary to know the relations that hold between these propositions. The square of opposition of propositions exhibits all the possible relations that obtain between A, E, I and O-propositions. We may define opposition of propositions as a kind of relation obtaining between two propositions having the same subject and same predicate but differing with respect to quality or quantity or both (i.e. both in quality as well as in quantity).

To obtain all types of oppositions, let us draw a square representing all the four types of propositions namely A, E, I and O. This is called the square of opposition of propositions.



Square of opposition of propositions

Here, our representation of propositions by use of a square is such that the upper two tips of the square represent the two universal propositions 'A' and 'E', while two lower tips of the square represent the two particular propositions 'I' and 'O'. Further, two affirmative propositions would be on one side of the square (in the present case they occupy the left side of the square) and other two negative propositions are on the right side of square. As it is shown by use of the square, there can be four types of oppositions of propositions namely (I) Contradictory, (ii) Contrary, (iii) Sub contrary and sub alternation. Let us discuss each of these.

i) Contradictory Opposition

This kind of opposition obtains between two propositions having the same subject and same predicate but differing both in quality as well as in quantity. Thus, the pair, A and O are contradictorily related. Similarly, E and I are also contradictraily related. Note that A and O-propositions and so also E and I propositions are different from each other with respect to both quality and quantity. A and O-propositions are qualitatively different because A-proposition is affirmative and O-proposition is negative. They are also quantitatively different as A-proposition is universal and O-proposition is particular. Hence, if one is true then the other must be false and also coversely. This means that they cannot be true together nor false together. For example, "All judges are lawyers" and "Some judges are not lawyers" cannot both be true together and they cannot be false together. If one is true then the other must be false and vice versa. Thus we derive the following logical principle from the denial of an A-proposition. The denial of an A-proposition yields an O-proposition with the same subject and predicate. For example. "It is false that all S is P" will be equivalent to "Some S is not P". Similarly, the denial of an O-proposition yields an A-proposition. For example, "It is false that some S is not P" will be equivalent to "All S is P". Similar remarks can also be made with regard to the relation between E and I propositions having the same subject and predicate which are also contradictorily related.

ii) Contrary Opposition

Contrary opposition is a kind of opposition that holds between two universal propositions

having the same subject and same predicate but differing only in quality. Thus, A and E-propositions are contrarily related. Here, the truth of A-proposition implies the falsity of E-proposition and the truth of an E-proposition imlies the falsity of an A-proposition. But from the falsity of either one, nothing about the other can be inferred. The truth of either one implies the falsity of the other. This means in case of contrary opposition, both cannot be true together but can be false together. For example, "All poets are emotional" and "No poets are emotional" are contrarily related. Beacuse the truth of "No poets are emotional" implies the falsity of "All poets are emotional" i.e. the truth of either one implies the falsity of the other. But, if one is false, the truth value of the other remains undecided. Thus we have the logical principle namely "the truth of A-proposition implies the falsity of E-proposition but not vice versa, and similarly the truth of E-proposition implies the falsity of A-proposition but not vice versa. (of course in both the cases the subject and the predicate remains the same).Thus we see that A and E-propositions are contraries that can be false together but they cannot be true together.

Sub-Contrary Opposition

Sub-contrary opposition is a kind of opposition holding between two particular propositions having the same subject and same predicate but differing only in quality. Thus, I and O-propositions are sub-contrarily related. Here the falsity of one implies the truth of the other. In other words, if an I-proposition is false then the correspending O-proposition is true. Similarly, from the falsity of an O-proposition, we can infer the truth of the correspending I-proposition. On the other hand, from the truth of one nothing can be inferred with regard to the truth or falsity of the other. Thus, I and O-propositions can be true together but they cannot be false together.

Sub-Alternation Opposition

Subalternation opposition is a kind of opposition between two propositions having the same subject and same predicate that have the same quality but differ in quantity. This opposition

holds between a universal proposition and its corresponding particular proposition. This opposition obtains between A and I-propositions as well as between E and O-propositions. In other words, the opposition between a universal proposition and its corresponding particular proposition is called sub-alternation. Technically speaking the universal proposition is called super-altern and the corresponding particular proposition is called subaltern. In this case, we say that (I) from the truth of super-altern, the truth of subaltern follows but not vice versa. Hence, the logical principle with respect to subalternation is (i) the truth of A-proposition implies the truth of I-proposition but not vice versa and (ii) Similarly the truth of E-proposition implies the truth of O-proposition but not vice-versa.

SUMMARY

A categorical proposition expresses a relationship between two categories or classes of things. It consists of a subject term and a predicate term joined together by a copula. According to quantity a categorical proposition is either universal or particular. According to quality a categorical proposition is either affirmative or negative. By combining these two principles of division we have a four fold classification of categorical propositions. These are universal affirmative (All S is P), universal negative (No S is P), particular affirmative (Some S is P), and particular negative (Some S is not P). These four types of propositions are named as A, E, I, and O respectively.

A term is either distributed or not distributed in a proposition. When we refer to all the members of the class designated by a term, the term is said to be *distributed*. When we say a term is *undistributed*, we mean that we are referring to some of the members of the class designated by that term. Distribution of a subject term depends on quantity. The subject term of a universal proposition is always distributed and the subject term of a particular proposition is always undistributed. Distribution of a predicate term depends on quality. The predicate term of an affirmative proposition is undistributed. The predicate term of a negative proposition is always distributed.

Two propositions having the same subject and predicate terms may differ from each other in quantity or in quality or in both. This differing relation between propositions, having the same subject and predicate, is called the opposition of propositions. There are five kinds of oppositions. These are contradictory, contrary, subcontrary, subaltern and superaltern relations. These relations are represented by a diagram, called the "Square of Opposition". Certain important truth relations hold between propositions having any of the relations of opposition.

Modern logicians point out that only particular propositions I and O have existential import. It has been argued that universal propositions A and E have no existential import. The consequence of denying existential import to universal proposition is that the traditional square of opposition of proposition cannot in general hold good.

The four types of categorical proposition A, E, I and O can be diagrammatically represented by drawing overlapping circles inside a rectangle by shading or putting 'X' in appropriate regions within the circles.

MODEL QUESTIONS

I. Answer the questions by choosing the option you think to be most appropriate.

1. "No officer who takes bribe is a respectable person." This is a

a) universal affirmative proposition.
b) particular affirmative proposition.
c) universal negative proposition.
d) particular negative proposition.

2. "Some teachers are honest." The quality of this proposition is

a) Negative.
b) Affirmative.
c) Particular.
d) Universal.

3. "Some students are hard working." The quantity of this proposition is

a) Negative.
b) Affirmative.
c) Particular.
d) Universal.

4. "All teachers of logic are teachers of philosophy." In this proposition

a) the subject term is distributed
b) the predicate term is distributed
c) both the subject and predicate are distributed.
d) neither the subject term nor the predicate term is distributed.

5. "No motorcycles are cheap vehicles" and "Some motorcycles are cheap vehicles." These two propositions are

a) subcontraries.
b) contradictories.
c) contraries.
d) none of the above.

6. If two propositions are contraries, they

a) will have the same truth values
b) will have opposite truth values.
c) may both be true, but cannot both be false.
d) may both be false, but cannot both be true.

7. The two propositions "Some motorcycles are expensive" and "Some motorcycles are not expensive" are

a) contraries.
b) subcontraries.
c) equivalent.
d) contradictory.

8. Assuming traditional square of opposition, if an A proposition is true then which one of the following holds?

a) O is false, while E and I are undetermined.
b) E is false, I is true, and O is true.
c) E is false, I is true, and O is false.
d) E is true, I is true, and O is false.

II. Reduce the following sentences to standard logical form.

1. Some soldiers will be wounded.
2. Hindus all believe in reincarnation.
3. No ancient traders were homesick.
4. Only reptiles are lizards.
5. No *Pandavas* were cowards.
6. All ancient Greeks worshiped Zeus.
7. Not every animal that can fly is a bird.
8. If anything is a chimpanzee, then it is not a fish.

9. At least one student is a leader.
10. Most of the students are athletes.
11. Few traders are benevolent.
12. Not all snakes are poisonous.
13. Whoever has studied logic knows the meaning of "syllogism".
14. Crows are black
15. Moths are not butterflies.
16. The whale is a mammal.
17. All that glitters is not gold.
18. A fool is not always wrong.
19. Books are generally useful.
20. Students are seldom rich.

III. Point out in each case whether the statement is true or false.

In the proposition "Some poets are eccentric persons" "some" may refer to only one poet.

2. Some categorical propositions are neither affirmative nor negative.
3. In the proposition "No journalists are cowards" the quantity is negative.
4. In the proposition "No dogs are cats" both the subject and predicate terms are distributed.
5. If two propositions are contradictory, they cannot both be true at the same time, but they could both be false.
6. The two propositions: "Some candidates are successful" and "Some candidates are not successful" are contraries.
7. The relationship of subalternation and superalternation are one-way relationships.
8. If the proposition "No student who adopts unfair means in the examination is a person who deserves our sympathy" is true, then the proposition "Some students who adopt unfair means in the examination are persons who deserve our sympathy" is false.
9. The proposition "All students are sincere" is subcontrary of "No students are sincere".

10. We always attribute existential import to I and O propositions.

IV. State, in each case, the quantity, quality and the form (A, E, I, O) of the proposition.

1. Some diamonds are not valuable objects
2. Some outlaws are heroes
3. No losers are winners.
4. All people who worship money are lunatics.
5. All individuals who lie frequently are deeply unhappy people.
6. Some logic teachers are not good singers.
7. Some numbers are not odd numbers
8. All mammals are cats
9. Some wealthy people are not dignified people.
10. No odd numbers are even numbers.

V. Name the relation (Contradictories, Subaltern-Superaltern, Superaltern-Subaltern, Contraries, or Subcontraries) that holds between following pairs of categorical propositions.

1. Some dinosaurs are not herbivores.
   No dinosaurs are herbivores.
2. Some philosophers are wise.
   Some philosophers are not wise.
3. All emeralds are stones.
   Some emeralds are not stones.
4. All gems are emeralds.
   No gems are emeralds.
5. All men are mortal.
   Some men are mortal.
6. Some teachers are very authoritative.
   All teachers are very authoritative.

7. No cows are goats.
   Some cows are not goats.

VI. (a) Given that A is true, what can be logically inferred regarding the truth or falsehood of its corresponding E, I, and O propositions?

(b) Given that A is false, what can be logically inferred regarding the truth or falsehood of its corresponding E, I, and O propositions?

(c) Given that E is true, what can be logically inferred regarding the truth or falsehood of its corresponding A, I, and O propositions?

(d) Given that E is false, what can be logically inferred regarding the truth or falsehood of its corresponding A, I, and O propositions?

(e) Given that I is true, what can be logically inferred regarding the truth or falsehood of its corresponding A, E, and O propositions?

(f) Given that I is false, what can be logically inferred regarding the truth or falsehood of its corresponding A, E, and O propositions?

(g) Given that O is true, what can be logically inferred regarding the truth or falsehood of its corresponding A, E, and I propositions?

(h) Given that O is false, what can be logically inferred regarding the truth or falsehood of its corresponding A, E, and I propositions?

Essay type questions :

1. Explain with examples the different parts of a categorical proposition.
2. Explain the four-fold classification of categorical propositions according to the mixed principle of quantity and quality.
3. What is meant by distribution of terms? Explain when terms are distributed in a proposition.
4. Explain with diagram the meaning of the traditional Square of Opposition.
5. What is meant by opposition of propositions? Explain and illustrate different kinds of

opposition of propositions.

6. What is existential import? Do all propositions have existential import? Explain.
7. What is Venn diagram ? Explain how the different forms of categorical proposition can be represented in Venn diagrams.

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CHAPTER - 5
NATURE, PROCEDURE AND PROBLEM OF INDUCTION

5.1 LOGIC : WHAT AND WHY ?

Man is inquisitive. He wants to understand the world around him. Man's reflection on life, nature and society has resulted in formation of ideas. This rational endeavour has indeed helped for the growth of knowledge. This process is going on from the early phase of human civilization to our age of technological sophistication. The knowledge that man acquires in an age is handed down to the posterity. That becomes possible because man is capable to communicate through language. That is why what was composed thousands years back are even available to us now and we are able to read and understand the mind of the people living in that remote past. Thus man's rational capacity and the ability to speak language have helped him to develop knowledge on very many fields.

Man is bestowed with sense organs and the intellectual capacity to comprehend the environment around him. By sense experience man learns many things about the physical world. By perceiving things, events and processes and mentally comprehending them he develops systematic body of knowledge which is called science. Science is a systematic body of classified empirical knowledge. Physics, chemistry, astronomy etc. are different branches of natural science. As nature is vast and unlimited there are different specializations in the field of natural science. Each branch of natural science studies and explores some invariant laws that operate in a particular area of nature. Physics, for example, explores the fundamental relationships between matter and energy, chemistry is concerned with the composition of substances and their reactions with one

another, astronomy studies the nature, position and motion of heavenly bodies, so on and so forth. Of course there are many areas of natural science which are complementary to each other. There is no watertight compartment between different areas of natural science, rather they collectively make a system.

Man, too, we know, is a social being. Human society has passed through various evolutionary changes. It has become stable in the long process of historical development. Man has also become interested to study his society in a systematic way. Consequent upon this study there are different branches of social science. Economics, political science, sociology etc. are branches of social science trying to interpret and explain the different social aspects of human life and behaviour. As there are different areas of social interaction, social sciences study them making mutual specializations.

Natural science and social science constitute the realm of physical science. Unlike physical science there is another branch of knowledge, which covers different areas of mathematics. Mathematics is a formal science in which theorems are necessarily brought out from the axioms, which are considered as self-evident. The relation between an axiom and its theorem or theorems is only implication or necessitation at an abstract level. That is, the structural character of formal science, say mathematics, is that of axiomatic deductive. Algebra, geometry, calculus etc. are some of the major branches of mathematics.

All these areas of knowledge- physical science and formal science- are founded on some methodological device. In each sphere of science some process of reasoning is applied to obtain accurate knowledge. Our knowledge in these spheres- whether obtained directly, indirectly or inferentially- assumes some process of reasoning. That is, any systematic or methodological knowledge is bound to adopt some definite procedure and employ some reasoning. The process, procedure or reasoning applied in a system of study ordinarily does not come within that system to be investigated. There is another area to consider and examine the different procedures or reasoning that is applied to have specialized knowledge of science. A physical scientist applies some reasoning, methodology and procedure to build up his system or reach some generalizations.

But he is not theoretically concerned with the methodology that he applies. This can be explained by an analogical example. A common man communicates his ideas or feelings through the language he has learnt. He makes intelligible communication by following the conventional rules of a language that he has learnt. A lay man or even an illiterate person finds no difficulty to make intelligible communication by following certain rules of grammar. For any intelligible linguistic communication presupposes some rules of grammer. A linguist or grammarian, on the other hand, studies the rules of grammar of a language at a theoretical plane which a common man presupposes or applies in practice without being theoretically conscious of them. Somebody may be using some rules without being conscious of them but they can be explained at a theoretical level. Similarly the methodology or procedure that is used in different areas of science is not analytically elucidated by the scientist. He has a practical understanding or implicit mastery of the procedure that is necessary for his system of knowledge to be formulated. But such procedures and the process of reasoning are analyzed and explained theoretically by a logician. A logician is not interested in making empirical generalization nor does he investigate the cause of a phenomenon. Such enterprise is carried out by a scientist dealing with empirical phenomena. But a logician on the other hand investigates the valid forms of reasoning and the theoretical procedure underlying any valid generalization. While exploring the valid forms of reasoning at a theoretical plane logic also studies the auxiliary processes connected with reasoning. Logic, therefore, can be taken as a reflective enquiry or in philosophical terms a second order activity. Its procedure is analytical or conceptual but not empirical.

Not only in intellectual pursuit but even in practical life we draw conclusion and usually make inference. Drawing conclusion, making inference, formulating arguments etc. are normal rational activities of a person. In the morning after getting up if one finds the ground is wet, he infers rain at night. On the road if we see a crowd and a vehicle lying we imagine an accident. After seeing two bodies with some facial resemblance one assumes that they are brothers. In such numerous occasions we very often make inference in practical life. But whether an inference is sound, appropriate or not requires understanding of the rules of valid reasoning.

Thus, logic is primarily concerned with the valid forms of reasoning. It lays bare the fundamental principles underlying the valid forms of arguments. In any branch of knowledge or even in the practical commerce of life we make inference and present argument. We draw conclusion on the basis of some evidence. When a conclusion is drawn form some evidence there is an inference. An inference is a mental process and its manifestation in language is called an argument. In other words when an inference is expressed in language it is called argument. Logic as a system of study deals primarily with criteria for the evaluation of arguments with a view to determining the conditions of their validity.

Classical logic centres round two areas such as Deductive Logic and Inductive Logic. Deductive logic received a systematic elaboration in Aristotle (384-322 BC). Inductive logic on the other hand had a late theoretical emergence. Although there were some scattered ideas about induction in the writings of some ancient and medieval writers, Francis Bacon (1561-1626) gave a systematic presentation of inductive logic. After Bacon there are a number of great thinkers who have made significant contribution to inductive logic. Before going to discuss the nature, problem and procedure of induction, a brief discussion on deductive logic i.e. the nature of deduction will throw insight to understand the perspectives of induction and the nature of logic as well.

NATURE OF DEDUCTION :

The structure of deductive arguments reveals that there is a necessary implication between the premises and the conclusion. The conclusion necessarily follows from the premises. So the reasoning here is conclusive. Further the conclusion cannot have more generality than the premises. What is already assumed in the premise can only be brought out in the conclusion. As there is a relation of formal entailment between the premise and the conclusion the conclusion cannot go beyond the premise. Let us take two examples to explain it:

1. All teachers are literate.

   ∴ Some literate people are teachers.

2. All philosophers are wise
Russell is a Philosopher.
∴ Russell is wise.

The first argument comes under immediate inference and the second one under mediate inference i.e. syllogism. In each case the conclusion necessarily follows from the respective premise or premises. To accept the premise and deny the conclusion would land us in contradiction. Further the conclusion in a deductive argument will always have equal or less generality than the premise or premises from which it is derived. Again one important characteristic of deductive reasoning is that the conclusion cannot have any novelty. It cannot give any new information that is not inherent in the premise. Thus in a valid deductive argument the conclusion can never extend our knowledge beyond the content of the premise. It only brings out or makes explicit what is implicitly inherent in the premise.

In a valid deductive argument since the conclusion necessarily follows from the premises, if the premises are true as a matter of fact, the conclusion must also be true. A false conclusion cannot follow from true premises in a valid argument. But if the premises are false, the conclusion will be false even if the argument is valid. Let us take an example-

All men are immortal.
All philosophers are men.
∴ All philosophers are immortal.

Here no consistency is violated since the premises do necessarily imply the conclusion. It is an argument in form of Barbara of the first figure. But here the conclusion is false as a matter of fact. The falsity of the conclusion is due to the fact that the premise "All men are immortal" is false as a matter of fact. So a conclusion can be false even in a valid argument if the premise is false.

Similarly in other cases the premises and the conclusion may be true. But the argument may be invalid. Consider this example:-

All men are mortal.
All students are mortal.

∴ All students are men.

In this argument the premises as well as the conclusion are ture as a matter of fact, but the argument is invalid. It is invalid because the conclusion does not necessarily follow from the premises for it involves the fallacy of undistributed middle. Thus truth and validity are different concepts. A proposition is true or false depending upon the situation it describes. If it tallies with the actual state of affairs, it is true otherwise it is not. But on the other hand an argument is valid or invalid. An argument is valid if its conclusion is being justified by the premises. Validity, therefore, is a rule guiding concept. If some rules of reasoning are satisfied with regard to an argument then the argument is valid. For there is complete justification or consistency between the premises and the conclusion. In an invalid argument the premises do not justify the conclusion. But it should be noted that once an argument is valid and the premises are true the conclusion must be true and can never be otherwise.

From this analysis it appears that in case of deductive reasoning the thrust is on formal consistency. Logic is primarily concerned with the forms of valid arguments. Logic has explored different forms of valid argumentation. Once a valid form is made explicit any subject matter filled into it will make the argument a valid one. Since the content of the argument may be anything a logician is not interested what the subject matter of an argument is. But on the contrary he is very much concerned with the form of the argument. For example, consider these two instances:-

a. No P is M
   All S is M
∴ No S is P

b. If P, then Q
   Not Q
∴ Not P

In the first example, (a), S, P and M stand for terms of a proposition and in (b), P and Q stand for propositions. In (a) whatever term will be substituted uniformly in place of S, P and M, will result in a valid argument. So too in (b) any proposition substituted in place of P and Q will make a real valid argument. For these are valid forms of arguments. Once the forms of valid argument are ascertained, any real argument can be symbolized into its formal structure. If the formal structure is in accordance with valid reasoning, then the argument, irrespective of its subject matter, will be treated as valid. Logic, therefore, is very much concerned with the forms of validity like mathematics. Deductive logic and mathematics are thus considered as formal sciences. A formal science has universal application. The procedure or reasoning in formal science is based on self-consistency. In mathematics, particularly in Euclid's geometry, the deductive procedure is evident. From a limited axioms hundreds of theorems are brought out by applying the deductive procedure. Great logicians and mathematicians have presented frameworks to show that from a very limited axioms with the help of a few definitions and rules of syntax any tautology, which is a necessarily true expression, can be derived. All these show that deductive logic is primarily concerned with the forms of valid reasoning.

NATURE OF INDUCTION :

There are regularities in nature and discovery of them advances human knowledge. From our varied experience when we notice some regularity and have explanation for it we make generalisation. For example we find living beings die, birds lay eggs, iron rusts, water flows downward, cats catch mice, matter gravitates etc. There are also irregularities in nature. We find some boys are intelligent but some are not, some mangoes are sweet but some are not, some birds sing but some do not, good harvest does not follow every year, etc. But science seeks exceptionless regularities of nature. These are like invariable generalisations. Generalisations are most significant in the sphere of human knowledge. For they are the very basis of all positive sciences. Not only in science in our practical life generalisations are very much helpful without which we cannot regulate our life.

When a generalisation is made it comes within the scope of induction. Inductive logic examines the conditions for appropriate generalisation. Theoretically it explains the basis and structure of a sound generalisation. By formulating the criteria for valid generalisation it distinguishes sound generaalisation from the illicit ones.

When a generalisations is made, it makes a universal proposition covering unlimited instances. When, for example, we say living beings are mortal, birds lays eggs, all quadruped animals are mammals, no bird is a mammal, etc. each such proposition is about a class of unlimited members. To say that all men are mortal is to make a general proposition of unrestricted generality for it not only covers known cases, it includes a vast number of unknown cases. Any such above proposition covers a large number of unobserved instances too. To say that 'No bird is a mammal' includes all birds of past, present and future. It covers unlined cases.

Since every physical science makes empirical generalisation, a question may very well be raised regarding the basis of such generalisation. It is found that our observation is the basis of generalisation. From our experience we find that birds are not mammals but lay eggs. On the basis of this regular experience we make the generalisation that all birds are non-mammals. On the other hand we observe from nature that cows, dogs, cats - all quadruped animals - are mammals. In case of such animals the female animal gives birth to babies and feeds them with milk from her body. Here the premises are based on verifiable or observable instances and are true. On the basis of particular experiences a generalization is made. Thus in induction there is generalisation on the basis of actual observation of facts.

But a genuine general proposition with unlimited totality cannot be established by experience. Experiences falsify a general proposition in face of observation of a contrary instance, but experience cannot justify the truth of a general proposition. We cannot individually verify every quadruped to be a mammal and then make the generalisation that all quadrupeds are mammals nor can we individually verify every bird and then make the statement that no bird is mammal. Since in these cases the conclusion is a general proposition with unlimited members it is beyond the scope of actual verification. But for all practical purposes we have no doubt on the

veracity of these generalisations. Thus in induction the conclusion is a real inference as on the basis of our observation we pass to a general truth of similar cases. Here there is a leap and every genuine form of induction carries a leap. A leap is a jump from the observed instances to unobserved cases, from some to all or from known cases to unknown cases of unlimited totality. This process of jumping from some to all, from limited cases to a generalised theory is said to be the "inductive leap". This characteristic of having a leap is an essential feature of inductive reasoning. An inductive inference is worth the name by virtue of its having the inductive leap.

Since the generalisation in induction is based on observation of particular cases the conclusion is probable in nature. The premises only lend support to the conclusion. The presence of the inductive leap makes the induction probable. Of course probability is a matter of degree, it may be very high or low depending upon the verifiable facts and their link with the conclusion. An induction however certain it may be, lacks absolute or logical certainty. A logical certainly is a conceptual relation but induction is a factual relation. In case of a genuine induction there may not be any contrary evidence, but the possibility of having any in future cannot be completely ruled out. Of course in an induction if the inferred characteristic is a structural feature of the class of which it is inferred then the degree of probability will be very high. More and more confirmation increases more and more the degree of probability rises. It the generalisation is not an isolated theory but linked with other theories and laws at a fundamental level then its degree of probability will be high. But the significant point is that the support of the premises for the establishment of a generalised fact can never be complete. It can enhance the possibility of the conclusion but will never be final. Even the uniformities of nature established by some developed sciences are not totally free from the possibility of a modification or revision in future in face of new facts. Thus the very basis of an inductive generalisation is only probable in nature.

Any generalisation extends our knowledge, therefore induction has novelty. What we observe and finally what we infer are factually significant. And what is factually significant must have novelty. For it widens our knowledge and extends our information about the physical world. Inductions are also very much essential for practical purpose of life. By induction we imagine the

course of events to take place in future.

Thus inductions are very useful from the scientific as well as practical point of view. Therefore there must be a theoretical study to formulate rules and fix up some criteria for valid generalisation. That is what is done in inductive logic. Inductive logic provides a criteriological basis to study the different procedures of induction and examine the reasonableness of inductive generalisation.

5.2 RELATION BETWEEN INDUCTION AND DEDUCTION :

We notice that deduction and induction are the two distinct processes of reasoning. Each process of reasoning has its own distinctive features. The deductive process provides the theoretical basis to know how arguments are valid or invalid. The inductive process formulates the basis for generalsation and guards against illegitimate ones. For any wrong derivation or hasty generalisation is a logical commission that makes thinking opaque. Deduction and induction as processes of reasoning help know the rules and procedures of their respective mode and thus guard against fallacious inferences. Now let us discuss their interrelationship, i.e. their similarities and differences.

When a conclusion necessarily follows from the premises and there is a relation of implication between the premises and the conclusion, the reasoning is deductive. On the other hand when the conclusion does not necessarily follow from the premises but is supported by them the reasoning is inductive. That is, in case of induction even if all the accompanying evidences, the premises, are true, there is no certainty that the conclusion will be true. But in deduction if the argument is valid and the premises are true, the conclusion must be true.

There is a significant difference between deduction and induction. In deduction the conclusion cannot be more general than the premises but in induction the conclusion is always more general than the premises. In deductive reasoning from a principle we draw particular instances or a conclusion having lesser generality. But in induction from particular cases of observed instances we make a generalisation. While the premises in an induction are obtained from the observation of facts, the premises in a deduction are assumed to be true. Thus induction always proceeds from particulars to the general but deduction proceeds from general to less general or particular.

Again formal validity is the essential feature of a deductive argument. An argument is formally valid if the conclusion necessarily follows from the premises. In a deductive argument what is important is the formal consistency. The subject matter or the content of the premises is not of consideration, but the rules of inference. If the rules of inference are strictly followed, then the argument will have validity. This process or reasoning can be applied in any sphere of discourse, but the point at issue in deductive argument is formal justification of the conclusion. But in case of induction the point of formal validity is out of question. Here the conclusion is a generalisation, which should be true as a matter of fact. In an induction if the conclusion becomes true, then the purpose of induction is fulfilled. For induction aims at a real generalisation based on fact. Here there is a passage from a proposition true of some observed cases to a proposition true of all the cases of a particular class. All physical sciences apply inductive method in their pursuit of knowledge. In induction while the premises are based on experience in deduction the premises are assumptions. That is the accompanying evidence in an inductive generalisation comes from real experience, either through observation or experiment. But the premises in deductive argument are assumptions. The conclusion in an induction is like a generalisation which comes like a hypothesis. This requires more and more confirmation in its favour to be accepted as a theory or law in science. But the conclusion in a deduction is a logical outcome that necessarily follows from the premises accepted for the argument. So the reasoning in a valid deduction is very much conclusive. And here if the premises are true, the conclusion must be true. But in induction its very structure reveals that there will be different degrees of probability. Probability would be high or low depending upon its supporting evidences.

From the above consideration it appears that induction and deduction are two forms of reasoning. They are two different processes of inference. For deriving a conclusion from premises these two processes are applied in different spheres. While mathematical discourses use the deductive procedure all physical sciences mostly apply the inductive procedure. Since both of them are the process of reasoning they do help to build up systems of knowledge. There is no system of knowledge that can do away with any process of reasoning. Any intellectual pursuit or

system of thought takes the help of some form of reasoning to establish its conclusions. Induction and deduction are the two most significant processes of reasoning which have been explored in logic.

There are some deep-seated confusions with regard to the relation between induction and deduction. We should guard these confusions to have a clear perception of their exact relation or role. For the confusions not only mar their relation but also blur the role of induction or deduction.

There is a view that one is prior to the other. John Stewart Mill, for example, takes induction as prior to deduction. According to him in a deductive argument one premise must be a general proposition. But to get a general or universal proposition we have to take the help of induction. That is the general proposition of a deductive argument is obtained by induction, so induction has priority over deduction. Contrary to Mill's view Jevon holds that deduction is prior to induction. For in induction though the conclusion is a general proposition it is suggested as an insight on the basis of some observation. That is the general proposition is like a hypothesis which we imagine on the experience of particular facts. The hypothesis to be accepted needs to be verified deductively. Without verifying a hypothesis in a deductive manner it cannot be accepted as a proper inductive generalisation. That is induction requires prior deduction for verification of the hypothesis. Thus according to Jevon deduction is prior to induction.

But this way of expressing their relation is misleading as well as confusing. As they are two processes of reasoning they are mutually dependent. As they are inferential procedures they have some close link. But it is not correct to maintain that induction supplies a premise to deduction. Deduction makes an assumption and brings out the conclusion that necessarily follows from it. Deduction has nothing to account for the material truth of the conclusion or of the premise. So it is not to be accepted that induction supplies a premise to deduction.

Similarly the view that deduction is prior to induction is not correct. At the stage of verification for the confirmation of a hypothesis deduction is made. Deduction aims at formal consistency of an

argument. It contributes nothing for the confirmation of a hypothesis. A hypothesis is confirmed by direct or indirect observation of facts. So the view of Jevon that deduction has priority over induction is not a correct presentation of their relation.

Again some deductive logicians consider deduction to be more fundamental than induction whereas some inductive logicians treat induction to be more fundamental than deduction. Those who accept the fundamentality of deduction hold that all arguments- including inductive ones- are deductive in nature. Even inductive arguments can be expressed in deductive form. To say "all dogs are mammals" is to make an inductive generalisation on the basis of observation of facts. But deductive logicians like Aldrich and Whatley try to reduce the above inductive argument to a form of deductive argument like-

The dogs observed and the dogs not observed are mammals.

But the idea of "all dogs" include the dogs that are either observed or not observed.

∴ All dogs are mammals.

But this way of reducing an inductive argument to a form of deduction is wrong for what is brought out as a proof in the conclusion is first presupposed in the premise. What is aimed to be proved is at first assumed to be true. To assert that the dogs we have observed and the dogs we have not observed are mammals is to make an inductive generalisation. That can be done only if induction is accepted as a valid form of inference. Thus this attempt to reduce induction to a form of deduction is not justified.

Similarly some inductive logicians like J.S. Mill and Bain accept the fundamentality of induction over deduction. All arguments, they hold, are basically inductive for either they are from particular facts to other particular facts or from particular cases to a general case. Further for them deduction consists as a stage in every scientific generalisation. That is deduction only applies a generalisation obtained by induction in individual cases. For the proof of an induction, they maintain, deduction is required to apply a generalisation to some individual cases. The generalisation " all men are mortal" can be ascertained by applying it to individual persons. That

is deduction comes within the system of induction and therefore has a secondary importance.

But such a view is also not acceptable . It is not correct to say that all arguments are primarily inductive nor is it a fact that induction includes deduction. Rather induction and deduction are two fundamental and independent processes of reasoning having different spheres of application. Deductive reasoning aims at formal certainty or consistency whereas inductive reasoning aims at a true generalisation. Formal consistency has absolute certainty but no novelty, whereas a generalisation has novelty but no absolute certainty. So these two forms of reasoning are distinct from each other and it is not correct to reduce one to the other.

There are also misleading descriptions about deduction and induction. Some logicians describe induction to be an ascending process and deduction as a descending process. Aristotle held that induction is an ascending process for passing from particular cases to a general conclusion. Bacon too takes deduction as a descending process for passing from a general case to particular cases. Similar such expressions are used to characterise them or their relation. Sometimes it is held that induction moves upwards whereas deduction proceeds downwards. Some again describe them as reverse processes. For in deduction we proceed from general to particular but in induction we proceed from particular to general . These descriptions are misleading as they are expressed in ambiguous ways. Such descriptions in stead of making their characteristics clear rather blur their essential nature.

Further there is also attempt to overlook their essential distinction. It is sometimes maintained that deduction and induction are essentially similar on all important points. Some hold that their difference is only with regard to their starting point. There is fundamental similarity between the two as they are processes of reasoning. There is sameness as both involve inference and are founded on the ground of similarity. The sameness or similarity in deductive reasoning is expressed by the presence of the middle term. The link of the middle term with other terms helps to relate them in the conclusion and bring the premises and the conclusion into one system. In induction the sameness is expressed between the observed instances and the unobserved ones

as belonging to the same class. The generalisation in induction covers unlimited cases because of its essential similarity with the observed instances. Thus similarity is the basis of both, and their difference is only with respect to their starting points which is a superficial or marginal one. Consequently deduction starts from a general premise and draws particular cases from it. Induction on the other hand starts from the particular facts and establishes a general proposition. Thus while deduction applies or interprets the law to the individual cases induction interprets the observed instances by help of generalised principle or law. On the basis of this it is also maintained that induction proceeds from facts to ideas and deduction proceeds in the reverse direction that is from ideas to facts.

But this type of elucidation to marginalise their difference sometimes blurs their real distinction. Even the real significance of induction or deduction as a process of reasoning is also overshadowed by it. For instance it is not correct to say that induction always proceeds from particular to the general. At the higher stage of inductive generalistion facts are not interpreted by laws rather laws are brought under some higher law as is the case in non-instantial hypotheses. We shall discuss this when we explain the idea of secondary induction. Similarly it is not correct to say that deduction proceeds from idea to fact. For in deductive reasoning facts qua facts have nothing to do with inference. It is very formalistic in its very approach. To assume a generalised truth and to find out what it entails is the very task of a deductive inference. But in induction to relate the observed facts to some empirical law or the laws to some higher law or theory is the purpose of this inference. So deduction and induction are two significant modes of reasoning and their difference should not be belittled in metaphorical or ambiguous elucidations.

5.2.1 DEVELOPMENT OF INDUCTIVE LOGIC :

The above discussion shows that induction as a process of reasoning mostly infers a universal conclusion from particular instances based on observation of facts. We have already mentioned that inductive logic acquired a systematic expression with Francis Bacon. Later logicians also contributed significantly to it and discussed many allied and auxiliary topic associated with it. Particularly systematic study on philosophy of science largely contributed to the sphere of inductive

logic. In comparison with Deductive Logic Inductive Logic has a short history. But in spite of that it has made a headway and has become a consistent system for a theoretical study.

Though the term 'induction' at present has acquired a difinite connotation it was not used in a unitary sense in the past. Logicians and philosophers used the term in different meanings. Aristotle first introduced the concept. In his use of the term, induction connotes two different meanings. Scholastic logicians of the medieval period used induction in the Aristotlean sense and as such did not make any new contribution over and above Aristotle. Bacon and Mill employed the term to stand for some inferential procedure. They have made significant contribution in their discussion on induction and its allied topics. Modern logicians and philosophers of science have embarked upon induction and have thrown valuable insights. Thus in the course of the long period of reflection and discussion induction has now acquired a definite connotation and a conceptual boundary.

Aristotle, as mentioned above, used induction for the first time. From his use two meanings follow. In the first meaning, induction denotes a general principle that seems to be involved in a particular case. That is induction is a process to establish a universal relation in any event that is perceived. After perceiving two tables one of rectangular size and one of circular size we form the general proposition that a circle is necessarily distinct from a rectangle. That is 'induction' used in this sense simply denotes a relation on the basis of perception.

Aristotle also used induction in a second sense. In this sense induction is the establishment of a universal proposition on the basis of observation of all the instances covered by it. Here the supposed universal proposition has a limited number of which each one has been separatrly verified. Thus after exhaustive enumeration of all the cases there can be a summary of the facts observed in form of a universal proposition. Statements like "all the planets of the sun have gravitational power", "all continents are inhabited by living beings" etc. are examples of induction. Here the subject has limited number, each of which can separately be perceived. This notion of induction of Aristotle has been characterised by later logicians as perfect induction or induction by complete enumeration.

Logicians in the medieval period did not make any new contribution to the idea of induction. They used induction in the sense of complete enumeration as done by Aristotle in his second sense. They thus used induction in the sense of enumeration. In this context there is reference to the idea of perfect induction or imperfect induction. If all the instances or particulars coming under the universal proposition are separately verified for making an induction, it is called perfect induction. But the establishment of a universal proposition on observation of some instances is called imperfect induction.

Then it was Francis Bacon(1561-1621) who made some significant contribution to the idea of induction. He used induction in the sense of establishing a form or essence of the natural things. By essence or form Bacon meant the invariable laws of nature. According to him by induction the regularities or the invariable laws of Nature can be discovered. He maintained that through observation and understanding of nature general laws can be arrived at. He emphasised not to overlook the negative instances, if any, before making a generalisation. He also explained the steps to be adhered to in the process of making a generalisation.

After Bacon, the next important name in the development of inductive logic is that of J.S. Mill(1806-1873). Mill analysed the experimental methods. These methods are the methodological procedures of induction that enable to explore that cause of any specified phenomenon. He also emphasised on true generalisation. According to Mill a generalisation means asserting the fact that what is true of some instances of a class under certain conditions is also true of all the members of the class. That is what is true at certain times will be true at all times under similar circumstances. Mill further holds that scientific induction is the best or ideal form of induction. For scientific induction is founded on the veracity of a causal relation. If induction will be based on uncontradictoriness of our experience i.e.on the basis of mere enumeration of facts, its result would be only probable. But according to Mill scientific induction is founded on the basis of a causal connection. A causal relation between two phenomena can be proved by the use of any of the five experimental methods that he explored. Mill's view is that the generalisation of the scientific induction will be certain as a causal relation is proved there. Any induction founded on causal

relation is certain according to Mill.

Most of these ideas have contributed to the development of the inductive system though they have been largely modified or changed by modern logicians. There is a great deal of advancement upon Aristotle's view or of Bacon's form. Induction is no more understood in the sense of exhaustive enumeration nor is it restricted to the discovery of form as Aristotle and Bacon hold respectively. Similarly Mill's view of proving a causal connection has not been accepted. Mill's view that scientific induction is absolutely certain has been criticised. Modern logicians hold that absolute certainty is not warranted in matters of empirical truth. Inductive generalisations are not certain in the way mathematical or analytical expressions are certain. What is true as a matter of fact can never have the certainty that is there in case of an analytic or verbal proposition. An inductive generalisaion might have high degree of probability but cannot have formal certainty.

Thus some of the views or ideas have been changed in the light of new insights or explorations. That shows man's intellectual creativity. Thus though most of the ideas of Aristotle, Bacon and Mill have undergone modification, they are considered as great pioneers of Inductive Logic.

5.3 PRIMARY AND SECONDARY INDUCTIONS :

There are theories and laws in every branch of science. Every theory in physical science is a generalisation. By observing events and processes theories are formulated for their explanation. Observation of regularities in Nature also prompts to make generalisation. Generalisations like water freezes at zero degree temperature, water expands when freezes, water splits into hydrogen and oxygen etc. also require explanation by some theories or laws. Whether it is a theory or law, it is basically a generalisation. Every significant generalisation in science possesses explanatory power. All genralisations are obtained by induction. Looking at all the generalisations and their explanatory power a distinction has been made between primary induction and secondary induction. A primary induction is in the form- " All the observed A's are B's; therefore all A's are B's. That is on the basis of observation of a limited number of cases a generalisation is made about all the cases. Here the conclusion is a general real proposition. In case of secondary

induction certain theories are formulated but not on the basis of observation of particular facts. Here there is systematisation of the theories by help of a higher theory. That is secondary induction aims at explaining theories by systematising the existing theories or laws.

Let us analyse them in some detail and bring out their characteristics.

PRIMARY INDUCTION :

a). Primary induction depends upon observation of facts. At first a number of cases are observed either from nature or under controlled conditions to establish a general proposition. We observe instances of birds laying eggs, whales as mammals, iron wires conducting electricity etc. On the basis of our experience of facts we make generalisition that " all birds lay egg and are not mammals", "all whales are mammals" or " iron is a conductor or electricity" etc. To reach these genreralisations we have to depend on actual observation or experiment of facts.

b). The conclusion in primary induction is a general real proposition. A general proposition covers cases of unlimited generality. The subject here denotes a class having innumerable number of individuals. It represents a whole class. To say "all men are mortal" or "no cow is a biped" is to refer to a class with unlimited individuals. Further a real proposition is one in which the predicate gives some new information about the subject. Hence a real proposition is either true or false as a matter of fact. But in a verbal proposition the predicate simply repeats either a part of the meaning or the whole meaning of the subject. A bachelor is unmarried, a triangle is a three sided plane figure, two and two equals four etc. are all verbal propositions .A verbal proposition is necessarily true and its opposite is necessarily false and self contradictory. But the opposite of a real proposition is a real proposition. The opposite of a real proposition may be false but never self-contradictory. Thus a real proposition is completely different from a verbal proposition. The conclusion in primary induction is always a real proposition.

c). Primary induction involves an inductive leap. When we say "All A's are B's" it indicates that every A is B always and everywhere. Since the conclusion is a general real proposition of unrestricted totality there is a genuine inference here. For we observe some cases of A being B

and on the basis of this experience when we assert that 'all A's are B's', it involves a leap. It is an inference since we draw a conclusion on the basis of some observed facts. When we pass from some cases to all cases, from present experience to a general theory it is said to be the inductive leap. To pass from some to all, from observed to unobserved, from known to unknown is not possible by any deduction, rather the reasoning here is inductive. So it is known as inductive leap.

d). Primary induction is based upon resemblance of facts. Resemblance or similarity is the very basis of an inductive inference. When we observe some instances for a generalisation, they belong to a category or class. The unobserved individuals belong to the same class of observed individuals. This jump from the known to the unknown covering a class of unlimited individuals is on the basis of structural or fundamental similarity between the observed individuals and the unobserved ones. Since we observe some whales to be mammals we generalise that all whales are mammals for whales constitute a biological class having fundamental resemblance. So on the basis of resemblance a generalisation is made. This is the very basis of induction according to Mill. He maintains, "Induction, then is that operation of the mind, by which we infer that what we know to be true in a particular case or cases will be true in all cases which resemble the former in certain assignable respects."

e). The conclusion established by induction is probable. In primary induction the conclusion involves a leap. The very presence of an inductive leap renders the conclusion to be probable. Since the conclusion here is a real proposition having factual import, it cannot be logically certain. To say all men are moral or no bird is a mammal is to make an assertion of fact. Here even though not a single contrary evidence is ever known and even if such generalisations are founded on well-established theories of science, still they are not to be taken as anaytically true. The degree of probability may be very high, but it is not logically certain. There cannot be logical certainty in case of synthetic propositions, which describe empirical facts. Only an analytic or verbal proposition can assume logical certainty. But a real proposition by definition lacks logical certainty for its opposite is also a possibility in the empirical world. Since the conclusion established

by primary induction is a real proposition it enjoys novelty but not logical certainty. It has novelty for it is factually informative or descriptive. Where there lies novelty, there cannot have logical certainty.

SECONDARY INDUCTION :

In some advanced sciences there is attempt to build some higher theories to systematize the generalisations. No observation of facts is made for this. When a higher theory is imagined for enhancing the explanatory power of some theories it is a case of secondary induction. For here there is no observation of facts unlike that of primary induction to think of a hypothesis. The hypothesis imagined in secondary induction will provide possible explanatory models to some existing theories or laws of science. Since the hypothesis here has nothing to do with the cases of factual instance, it is called non-instantial hypothesis. It is done in developed sciences. Thus when there is induction of a non-instantial hypothesis to provide explanations to the theories of science, it is called secondary induction. It is different from primary induction for unlike the latter it is not making an induction on the basis of observation of facts. But the induction here aims at systematizing the theories of science by some higher theory. Let us see what are the important characteristics of secondary induction.

a. It establishes a transcendental or non-instantial hypothesis. Here a higher theory is imagined to systematize the existing theories. This higher theory is supposed to provide explanatory framework to the existing theories. The supposed theory is a hypothesis having no instantial exemplification. Therefore it is sometimes characterised as a transcendental or non-instantial hypothesis. The law of universal gravitation, the theory of relativity, the black-whole cosmological theory to account for the origin of the universe are such theories. These hypotheses have no direct instances to be observed, but they are non-instantial ones to systematize some existing theories. Thus when the supposed hypothesis is considered to propvide a systematic explanation to the existing theories or laws, it is considered to be a case of secondary induction.

b. Secondary induction applies a hypothetico-deductive method. In secondary induction a non-instantial hypothesis is formulated which is supposed to possess great explantory power. Forming a non-instantial hypothesis is formulated which is supposed to possess great explanatory power. Forming a non-instantial hypothesis requires a great insight. Only a genius can think of such a hypothesis for it requires a sharp mind and powerful ability to imagine. When such a hypothesis is made it is not subject to ordinary confirmation for it has no instance or exemplification. But such a hypothesis is verified in some indirect way by the deductive method. By applying the method of deduction to it, theories are brought out and tallied with the existing laws. If the well established laws are deduced from the hypothesis, then only the theory can be accepted. Thus a non-instantial hypothesis established by secondary induction must have high explanatory power in order to be accepted. Its explanatory power gets confirmed more and more if the consequences brought out from it agree with the existing laws. The existing laws are well founded by it. They coherently make a system with the help of the non-instantial hypothesis. That establishes its veracity..

c. The conclusion obtained by secondary induction is tested only indirectly. When a hypothesis is formed to account for an explanation of a phenomenon or a class of phenomena, the hypothesis is normally put to verification before it is accepted. Verification may be direct or indirect in case of instantial hypothesis. Direct verification consists in observing or experimenting the fact to see whether the hypothesis is a legitimate one or not. Where direct verification is not possible because of the complexity of the situation, lack of necessary equipment for the purpose or absence of instantial exemplifications indirect verification is resorted to. Thus in case of non-instantial hypothesis not only there is absence of instances, there is great complexity for its verification by any direct method. So indirect mehtod of verification is the only available way to test its veracity.

Indirect verification includes deduction or accumulation of evidences. But accumulation

of evidences is also not that easy in non-instantial hypotheses for there is no instance exemplifying it. So the method of deduction is applied here. From the non-instantial hypothesis laws of lower or the lowest variety are drawn by help of deduction. They are tested by tallying them with facts. This test is done under varying circumstances to provide a possible basis for the acceptance or rejection of a non-instantial hypothesis.

d. The conclusion is probable in nature. All inductions, whether primary or secondary, are probable. Since induction makes generalisition which ultimately relates to facts it cannot possess logical certainty. A generalised theory or law admits innumerable instances which can never be exhaustively verified. So all inductions are probable though the degree of probability differs.

When a single contrary evidence is found or some discripancy is observed with regard to any generalised theory or law it arouses suspicion and leads to imagine some new hypothesis. Any theory or law, therefore, is subject to change or modification as there is no limit to scientific discovery or innovation. Thus any hypothesis, whether instantial or non-instantial, is probable in nature and that is an accompanying characteristic of any empirical generalisition.

Thus the distinction between primary induction and secondary induction throws insight to describe the nature of induction. The descriptions of induction as given by Aristotle, scholastic logicians, Bacon, Mill etc. are inadequate. That is because their descriptions do not cover all aspects of the concept as it is understood in recent time. At present it is maintained that inductive logic is basically concerned with the procedure and methodology of all sciences. It also discusses other allied and auxulary issues associated with the procedure of science. An empirical science aims at discovering exceptionless regularities- called theories or laws- and the systematization of the laws by a coherent system or order. That is done by the help of the procedure of induction. So let us turn to the issue of the procedure of induction.

5.4 PROCEDURE OF INDUCTION :

Science gives us systematic knowledge. Scientific explanation is dependable, for it adopts a viable technique. The technique that is adopted in science is the most assured or adequate technique that has been explored in course of man's intellectual inquiry. This technique is the inductive procedure. Every branch of science explains facts, classifies them, builds up theories to explain the facts, systematizes the theories with higher ones, discovers exceptionless regularities of nature etc. by adopting the inductive procedure. Thus the procedure of induction is the basis of all scientific knowledge for it is applied in all areas of scientific inquiry. The procedure of induction passes thorough some well-marked stages. Though logicians are not unanimous regarding the relative importance of a stage over others, nontheless they do agree that each stage of the procedure has some important role and helps in the system of scientific knowledge.

The different stages of inductive procedure are(i) observation of facts (ii) formation of hypothesis, (iii) generalisation and (iv) verification. Let us explain these a little elaborately.

(i) Observation :

When there is inquisitiveness to know something, we make observation. Thus observation is perception, but it is regulated and selective perception. It is in this sense different from casual perception for in observation we select the phenomena to be observed for a definite purpose. Observation here is used in a wide sense to include experiment as well. Observation and experiment constitute the ground of making any inductive generalisition or scientific explanation. To have a clear idea about some fact, we selectively choose from the complex occurrence of nature those phenomena that will help us in our study. Thus observation is the starting point to explain a fact that we desire to know. Observation again includes steps like definition, analysis, elimination and varying the circumstances.

a. **Definition-** The observer first makes his point clear what he is gong to observe for his purpose in a situation. Since nature appears very much complex and at times very baffling the observer makes his selection of the phenomena that he will take note of for his work.

This clarity and definiteness with which one begins his observation is called definition.

b. **Analysis-** The second step in observation is analysis of the situation. Since nature presents complex situations, the observer simplifies it . He resolves a complex situation into its constituent conditions. Then the observer selects those phenomena necessary for his purpose and avoids other accidental factors. That is after breaking up a complex situation the relevant conditions are picked up for the investigation. Since an event consists of different conditions, or irrelevant factors selecting the relevant matters for study or explanation is very important.

c. **Elimination-** In the process of observation then comes elimination. Elimination literally means rejection. In the process of investigation to explain a phenomenon the inessential or irrelevant factors need to be eliminated or rejected so as to facilitate for required observation. Since analysis distinguishes the essential conditions from the irrelevant ones, the irrelevant conditions are rejected by this analysis.

d. **Varying the circumstances-** To reject the accidental or irrelevant conditions it is necessary to separate them from the necessary and relevant conditions. To know which conditions are relevant and which are not, it is necessary to vary the circumstances. That can be done by observation of the circumstance under different changing situations. That is if an event is studied under the changing situations, then the observer may be able to know which of the conditions are important to explain a phenomenon.

Thus all the above steps are considered important to undertake systematic observation for an objective study of some circumstance. Francis Bacon lays great emphasis on observation.

ii) Formation of hypothesis :

The next step in procedure of induction is formation of a hypothesis. A hypothesis is a provisional supposition to explain a phenomenon whose explanation is not known. In the process of observation after eliminating the changing circumstances the common factor present in all the

instances is considered seriously to be the cause. Since nature is very complex it requires great insight to imagine what might be the cause of a phenomenon. To find out the real explanation of a phenomenon, we consider some possible situation. That is on the basis of our observation we fix upon one condition to a possible explanation of the phenomenon. That is considered as a hypothesis. To explain an event what seems to be the most probable explanation in the context is provisionally admitted. This provisional supposition is put to test under varying circumstances in a regulated way. In the process of test either the hypothesis is accepted or rejected on the basis of its agreement or disagreement with the fact respectively. That is if further observation confirms the hypothesis by supportive evidence then the hypothesis is corroborated. If it does not corroborate the facts, then the hypothesis is rejected and a fresh one may be thought of. The process goes on till a satisfactory explanation of the event or events is found out.

Whewell attaches great emphasis on framing of a legitimate hypothesis. According to him framing of a hypothesis is the most important step in the procedure of induction.

iii) Generalisation :

Science is not interested to explain a single phenomenon but a class of phenomena by formulating a general principle. It is not sufficient that a hypothesis explains some isolated phenomena but should provide an adequate explanation to all cases of the similar type. If it is observed that a particular hypothesis is able to explain the phenomenon under investigation we infer that it will be the explanation for all similar cases. That is on the basis of observation of particular cases we make a generalisation that the same is true in all cases of the similar type. If in some cases it is observed that the presence of a bacteria results in some unusual symptom, it is assumed that wherever this symptom is found, the bacteria must be there. So generalisation forms the basis of scientific explanation. This also results in the advancement of knowledge for we pass from the known or observed instances to unknown and unobserved cases.

Mill has attached great importance to generalisation for he thinks that induction becomes complete at the stage of generalisation. He maintains that the experimental methods conclusively

establish a causal relation so the methods help for a generalisation. But inductive generalisations can never have absolute certainty but can have high degree of probability. For the possibility of a generalisation being false in face of new facts cannot be ruled out. But generalisation constitutes one of the stages of inductive procedure.

iv. Verification :

When the hypothesis is generalised it requires verification to ascertain that the general proposition is true under all similar circumstances. The verification of a general proposition makes it a law. Verification means confirmation by appealing to facts. This is done either directly or indirectly. Direct verification is done either by observation or by experiment. Indirect verification is done either by deduction or by accumulation of evidences. In case of indirect verification conclusions are drawn from the hypothesis and compared with real situations. Or else facts are collected or accumulated and compared with the deductions from the hypothesis. Verification of a general proposition involves some deduction. For here particular conclusions are drawn from general proposition and compared with facts. When there is more and more confirmation of it, there is more and more acceptance of the hypothesis. That is, adequate objective tests add to the confirmation of the generalisation.

Jevon attaches great importance to verification in inductive procedure. For him it is the most essential requirement to ascertain an induction because the facts must be in conformity with the generalisation. Since it is done by deduction, Jevon, as already stated above, has attached more fundamentally to deduction.

Apart from these well-defined stages of inductive procedure philosophy of science gives importance to the idea of a system which can be taken as the next stage of inductive procedure. That is in advanced branches of science any empirical generalisation must be in agreement with the system of prevalent laws. All the generalisations must be making a coherent system and any new discovery must be placed in the system in order of its generality. The idea of non-instantial hypothesis of finding out higher and higher theories to explain different theories and laws-which are also generalisations- is gradually becoming more important in advanced branches of science.

The idea is that the empirical laws which explain the facts are not a loose bundle but again grouped under a few higher laws, theories or principles. In this way they make a coherent system in which the mutual interrelations of different generalisations do agree with facts and the advanced theories. Thus the inductive procedure aims at establishing a system and order. While the knowledge of facts is established by different generalisations or laws, the laws themselves constitute a unifying system by higher generalisations.

Thus any systematic scientific explanation or induction passes through the above stages which constitute the procedure of induction.

5.5 PROBLEM OF INDUCTION :

Induction, whether primary or secondary, infers a general real proposition. It is a generalisation with factual significance. A generalisation describes a relation of invariance between two things. It is like "all A's are B's". If we say 'all cows are ruminant', 'all men are mortal', 'no bird is a mammal' etc. we are marking generalisations. In such a case the subject term denotes unlimited and uncountable individuals of that class. When an assertion of the sort " All A's are B's" is made and A stands for a class of unlimited individuals, the description here is like a universal phenomenon of nature. A universal phenomenon is a law of nature. When we say " all material bodies gravitate on earth" or "all living beings are mortal" etc. such desriptions are considered as universally true. It is not the case that known cases are true, but it signifies that all the cases of this sort are true. It is not true here and now, but it is true everywhere and always as far as our experience goes. So on the basis of our experience of some A's are B's we make generalisation that all A's are B's, that is all A's are B's always and everywhere.

Thus a generalisation ranges over unobserved, unlimited and infinite number of cases. Our experience, however wide it may be, cannot exhaust all the cases covered by such a proposition. Hence an induction consists of a leap. An inductive leap means a jump from some to all, from observed cases to unobserved cases, from the knowledge of a limited instances to the knowledge of all. But how is this jump justified? What is the basis for accepting the proposition

"All A's are B's" always and everywhere on the basis of our experience of some A's are B's? This is the problem of induction.

Different attempts have been made by logicians to find out solution to this problems right from Aristotle. Aristole tried to solve this problem of induction unsuccessfully by deduction. Aristotle who was the founder of the deductive procedure applied the deductive method in finding out a solution to the problem of generalisation. For example, Aristotle justifies an induction by deduction-

Gandhi, Sankar, Buddha, Russell, Kant, Plato etc. are mortal.

Gandhi, Sankar, Buddha, Russell, Kant, Plato etc are all human beings.

∴ All human beings are mortal.

This attempt to draw a conclusion covering a generalisation is not sound. The premise, "Gandhi, Sankar, Buddha…… etc. are mortal" is not at all exhaustive for we cannot examine all human beings. While the conclusion is about all the members of a class, the premises are about some individuals. In a valid syllogistic argument we cannot draw a conclusion covering all members of a class from the observation of some members of that class. From "Some A's are B's" it is not possible to deduce. "All A's are B's. The very attempt to infer a conclusion with unrestricted totality from the premises of a limited number in a deductive manner is unsound. So by deduction we cannot arrive at a generalisation from particular instances. Therefore the leap remains, and since it is a problem of induction, this cannot be solved by any deductive procedure. Thus Aristotle's attempt at a solution is not sound.

J. S. Mill holds that the solution to the problem of induction lies on our acceptance of two very fundamental laws called the law of causation and the law of uniformity of nature.

So far the law of causation is concerned it assumes that every event has a cause. Mill accepts the law of causation as a universal principle that can be the basis for inductive generalisation. The law of uniformity of Nature assumes that nature is governed by uniform laws. In other words nature functions in the same manner under similar circumstances. That is the way we have observed things in the past will also continue to happen in the future. Since Mill holds that the problem of

induction can be solved by these two laws if a causal relation is established between two phenomena in respect of some essential point, even one or two instances will be sufficient for a generalisation. But unless a causal relation is ascertained hundreds of cases will not provide a basis for making a generalisation. So according to Mill the law of uniformity of nature and the law of causation form the basis to solve the problem of induction.

But Mill's assumption that causal relation is absolutely certain which can be proved by experimental methods is misleading. First of all the experimental methods-that will be discussed in a laler chapter- do not conclusively prove a causal relation. Causal relation is an empirical relation but not a relation of necessity or implication. Further all inductive generalisations are not about a causal relation. In some areas of knowledge a causal relation is required but in other areas no causal explanation is sought for generalisations. That is scientific explanation or induction is not to be restricted to a causal explanation. Science makes generalisation on different grounds. On the basis of statistical records, resemblance or analogical similarities generalisations are made. When a generalisation is made it may be a hypothesis that needs gradual confirmation by deduction and observation. Thus Mill's analogy to solve the problem of indication has not received universal acceptance.

In logic our purpose is to see how far a generalisation is dependable. Logicians fix up standard to assess the veracity of generalisation. Right generalisations are distinguished from illicit or unfounded generalisations. What sort of evidences can provide a sufficient basis for a generalisation and what sort of evidences are irrelevant to a generalisation need to be distinguished. Since inductive generalisations are propositions with factual import, they cannot be conclusively established or proved. Rather they carry degree of probability with them. Thus the problem of induction can be tackled at a pragmatic level. We go on discovering the secrets of nature, its exceptionalness regularities more and more by help of the inductive procedure. That means the regularities of nature can be discovered by the inductive procedure as that constitutes the very objective of science. So whatever generalisations are made following the inductive procedure account for scientific explanation. That constitutes the rule-of-the scientific-game and its procedure.

SUMMARY

LOGIC : WHAT AND WHY ?

Science is a systematic body of classified knowledge. While a branch of natural science explores the invariable laws that operate in a particular area of nature a branch of social science studies human behavior and social interaction in some sphere of society. Natural science and social science constitute the physical science as different from formal science.

But each branch of science applies some method, procedure and process of reasoning to reach its conclusions. These are not studied by science but analysed at a different sphere.

Logic primarily examines the valid forms of reasoning and the procedure underlying any valid generalisation. It deals with the criteria for the evaluation of arguments.

Classical logic centres around two areas such as Deductive Logic and Inductive Logic.

Deduction and induction.

In a valid deductive argument the conclusion necessarily follows from the premises. There is a relation of implication between the premise and the conclusion. In deductive reasoning the thrust is on formal consistency. Deductive logic explores the forms of valid reasoning.

Inductive logic examines the conditions for appropriate generalisation. Science makes generalisation on the basis of observation of exception less regularities of nature.

Inductive generalisation involves a leap. So a generalisation is only probable. Probability admits of degrees.

The deductive procedure is applied in mathematics but the inductive method is applied in physical science.

Deduction and induction are two different processes and their sphere of application is also different.

Some incorrect or misleading views with regard to the relationship between deduction and induction are-

a) Deduction is prior to induction or induction is prior to deduction.

b) One is fundamental than the other.

c) Deduction is a descending process and induction is an ascending process.

d) Induction and deduction are essentially similar and their difference is only with regard to their starting point.

PRIMARY INDUCTION AND SECONDARY INDUCTION :

In primary induction a generalisation is made on the basis of observation of facts. In secondary induction theories are formulated having greater explanatory power. The generalisation in primary induction has empirical instantiation but the generalisation in secondary induction is a non-instantial hypothesis.

PROCEDURE OF INDUCTION :

The procedure of induction is the basis of scientific knowledge. The procedure of induction passes through the different stages like-

a) Observation of facts including definition, analysis and elimination by varying the circumstances;

b) formation of hypothesis to explain a phenomenon;

c) generalization;

d) verification by appealing to facts;

e) the generalisation must be coherent with a system.

PROBLEM OF INDUCTION :

A generalisation is like a universal phenomenon of nature covering unlimited cases. It ranges over unobserved and unlimited number of instances. The problem of induction is how to bridge the leap between the observed and limited cases to the unobserved and unlimited cases.

Aristotle justifies induction by deductive procedure and Mill solves the problem of induction by appealing to the law of uniformity of nature and the law of causation.

MODEL QUESTIONS

GROUP – A

Objective Questions :

1. Answer the following :-

i. What is the first step in inductive procedure?

ii. What is the last step in inductive procedure?

iii. Who holds the view that hypothesis is an important step in inductive procedure?

iv. According to whom induction is complete only after verification?

v. Is it correct to say that induction is prior to deduction?

vi. Is deduction the only fundamental process of reasoning?

vii. What are the principles upon which Mill attempts to solve the problem of induction?

viii. Point out one of the basic differences between deduction and induction.

ix. Give an example of a general real proposition.

x. Is it correct to say that deduction is a descending process and induction is an ascending process?

xi. What is meant by analysis?

xii. Give an example of an illicit generalisation.

2. Fill in the blanks :-

i. Induction establishes the _____ truth of a general real proposition.

ii. According to _____ induction is complete at the stage of generalisation.

iii. According to _____ induction is complete only after verification.

iv. Induction is a process of generalisation from _____ instances.

v. Elimination of irrelevant factors is possible only after _____.

vi. The principle of causation states that for every _____ there is a cause.

vii. The principle of uniformity of Nature states that _____ behaves uniformly.

viii. Observation is _____ perception.

ix. Hypothesis is a _____ supposition.

x. _____ induction is primarily non-instantial in nature.

GROUP – B

Short type questions :

1. Answer the following :-

i. What is inductive leap?

ii. What is the problem of induction?

iii. Explain what you mean by secondary induction?

iv. What is primary induction?

v. What is generalisation?

vi. Name the different stages of inductive procedure.

vii. Point out some important differences between deduction and induction.

viii. What is an axiom?

ix. What is the law of causation?

x. Are induction and deduction complementary processes?

GROUP – C

Long type Questions :

1. Discuss the relation between deduction and induction as two processes of reasoning. Is any process fundamental than the other?

2. The evidence for a valid deductive conclusion is always complete but that is not so in case of an inductive conclusion- why it is so, explain.

3. What is primary induction? Distinguish it from secondary induction.

4. Explain with example the different steps involved in inductive procedure.

5. What is the problem of induction? How does Mill attempt to solve it? Discuss.

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CHAPTER -6

INDUCTION AND PROBABLE INFERENCE

Introduction :-

In the preceding chapter we discussed the nature and procedure of induction. We find that deduction and induction are two independent modes of inference. In deductive argument, the conclusion necessarily follows from the premises. The premises demonstrate the truth of the conclusion as they imply it. On the other hand induction deals with those inferences which derive universal conclusions from instantial premises. Hence inductive arguments are not to be classified as valid or invalid which is a characteristic feature of deductive arguments. But inductive arguments are characterised as probable, and there are degrees of probability. Again it should be noted that inductive logic does not formulate arguments, but studies the nature of inductive arguments with a view to laying bare the structure and procedure of generalisations.

Further it was noticed that the basis of primary induction is observation of particular instances. That is by observation or experiment of facts we are able to make inductive generalisations. Thus observation and experiment provide the material basis of induction. Again inductive leap is a very important feature of induction. Without inductive leap no inference can be characterised as truly inductive. Therefore having an inductive leap is considered as an essential feature of inductive generalisation. Further, because of the leap involved in induction an inductive argument is considered probable. Since all inductions are about propositions relating to matters-of-fact such propositions lack analytical certainly. Any such proposition is contingently true and its opposite is also a possibility. So probability is another important characteristic of an inductive generalisation. Thus having been based on observation of facts, having an inductive leap and

having been about the world of facts and thereby being probable are the significant characteristics of induction proper. In absence of any of these characteristics no inference can be considered as induction proper. Hence any process of inference can be characterised as inductive if its conclusion is based on observation of instances, possesses an inductive leap, i.e. passes from some to all or observed to unobserved and is a real proposition which is only contingently true. There are three such kinds of inference and they are scientific induction, unscientific induction and analogy.

There are some simulating forms which give the appearance of being induction but are not inductions at all. Any inference that does not possess the essential features of induction is not an induction. In some of the text books induction by complete enumeration, parity of reasoning and colligation of facts are named as induction-improperly-so-called. But since they are not to be classed as inductions calling them as induction is misleading. In induction by complete enumeration the conclusion does not possess any inductive leap for it is established after exhaustive enumeration. The conclusion here is a universal proposition based on observation of all facts connected with this induction. After individually verifying all the cases and subsuming them under one proposition a universal proposition is formed. So perfect induction by complete enumeration is more of a deductive argument than an inductive argument. To make assertions like 'every month of English calendar has less than thirty two days', 'every planet rotates round the sun', 'each student in a particular class knows English' etc. are examples of this type of induction. Similarly in parity of reasoning the conclusion is a mathematical assertion deductively drawn from some theories or axiom. Here it is taken that what-ever reasoning holds in a single case the same reasoning will apply in every other similar case. For example, after proving that the interior angles of a triangle are equal to two right tangles we generalise that the same reasoning will apply in case of every other triangle. So there is a generalisaion that the interior angles of every triangle will make two right angles. But such an inference is not at all inductive for it is not based on any observation of facts. Since it is not based on any observation of facts, the conclusion reached here is not a real proposition. The conclusion is a mathematical proposition which is necessarily true. So most of the important charcteristics of induction are lacking in induction by parity of

reasoning. Similarly in colligation of facts a set of observed phenomena is brought under a notion or a class name. After going round a building one forms the idea that it is an educational institute. In this form of reasoning new concepts are formed by binding together many observed facts. But no inductive leap is involved in this process of thinking. Thus induction by complete enumeration, parity of reasoning and colligation of facts are not considered as induction and therefore are not discussed in this chapter which deals with induction as a form of inference. Since they are only processes simulating inductions they will be dealt with a little elaboration in the chapter discussing Inductive Fallacies. Hence we shall discuss three basic forms of induction such as scientific induction, induction by simple enumeration or unscientific induction and analogy.

6.1 SCIENTIFIC INDUCTION :

Scientific induction is defined as the process of inferring the material truth of a general real proposition from the actual observation of particular instances of facts and phenomena in reliance on the law of uniformity of nature and law of causation.

Scientific induction is a kind of inference. It is a logical method of justifiably inferring a general proposition from a number of particular propositions. Let us take some examples-

1. Frog a is cold-blooded

   Frog b is cold-blooded

   Frog c is cold-blooded

   ∴ All frogs are cold-blooded.

2. Diamond a is not a conductor of electricity

   Diamond b is not a conductor of electricity

   Diamond c is not a conductor of electricity

   ∴ No diamond conducts electricity.

The form of reasoning applied here is:

S_1, S_2, S_3 . . . are P.

P is known to be causally related with each of S_1, S_2, S_3 . . .

∴ All S's are P.

CHARACTERISTICS :

From the definition of scientific induction its characteristics are obvious.

(i) Scientific induction seeks to establish a general real proposition.

The aim of scientific induction is to establish a proposition in its conclusion. A proposition is that which expresses a fact and is either true or false. Thus the conclusion of scientific induction establishes a general fact, but not a concept or idea, It does not intend to give a general notion rather gives a general proposition.

A general proposition is about the whole class of unlimited particular cases. In other words the predicate of a general proposition states something about the entire class of the subject term. A proposition, such as, 'all metals, when heated, expand', or 'all vipors are poisonous' is about unlimited and indefinite number of individuals of the class metal or the class vipor as the case may be.

Scientific induction does not aim at establishing particular propositions like 'some birds are black' or 'many people are bald'. Unrestricted generality is the hallmark of scientific induction.

But many propositions which appear to be general are not really general. For example, the proposition, 'all the districts of Orissa have colleges', is apparently general because of its form but really it is not general as it establishes the truth of a proposition whose scope is of a limited whole. These propositions are the conclusion of, what is called, perfect induction. Scientific induction must be distinguished from perfect induction.

Scientific induction establishes a general proposition which is real but not verbal. A real proposition is distinguished from a verbal proposition. A real proposition is informative and synthetic

in the sense that its predicate says something new about the subject. But in a verbal proposition the predicate states the meaning or synonym of the subject term. It gives no new information. The predicate states the connotation or part of the connotation of the subject term. For example, all brothers are male' or 'all mothers are women', are verbal propositions. A connotative definition states a verbal proposition in order to give the meaning of a term. In other words the predicate states the meaning of all subject term in a verbal proposition. In a general real proposition like 'All dogs are mammals' the predicate gives some new information.

ii) The data on which scientific induction is founded are facts of experience. To establish a general real proposition one must begin by observing particular instances. By observing the particular cases of death of persons we infer the general real proposition, 'All men are mortal'.

Observation can be performed by means of experiment and also by the help of instruments such as telescope, microscope and other sophisticated apparatus.

iii) There must be an inductive leap in scientific induction. As we start from the 'known' facts of observation to reach a conclusion about the 'unknown' we make a jump or take a leap.

The inductive leap is a passage from the observed to the unobserved, from some to all (particular to general) and from the known to the unknown. We observe some instances of frogs to be cold blooded and conclude that all frogs are cold blooded. The conclusion not only asserts about the observed cases of frogs but also about all the frogs of past, present and future which are not observed nor are they accessible for observation. Inductive leap, according to Mill and Bain, is the most important characteristic of any induction proper. No induction is possible without inductive leap. Perfect induction is no induction because it has no inductive leap.

iv) The conclusion of induction is more general than the premises. Thus the conclusion of an induction goes beyond the premises to say something by taking a leap. This is the reason why the conclusion of induction is always probable. In a deduction the conclusion necessarily follows from the premises so it gives formal certainty. But the conclusion of induction has only probability but no certainty.

v) Law of causation and the law of uniformity of nature are considered to be the formal grounds of induction. Scientific induction relies on the two laws as its basis. Inductive leap is justified because of the law of causation and the law of uniformity of nature. The law of causation is the characteristic which distinguishes scientific induction from induction per simple enumeration.

Law of universal causation states that everything or event has a cause. Law of uniformity of nature states that nature behaves uniformily. According to this law the same cause always produces the same effect under similar conditions. Thus the law of uniformity of nature, according to Mill, is the basis of induction which justifies the leap from the observed to the unobserved. The law of uniformity of nature is the ground of all inductions whereas law of causation as a ground of induction is an additional speciality in case of scientific induction.

For example, 'All cases of leprosy are cured by M.D.T', is a conclusion of scientific induction which is based on the known causal connection between leprosy and M.D.T. The conclusion about all cases of leprosy is justified because of the causal connection.

However in many advance sciences, generalisaions are not necessarily supported by a causal explanation. For example, on the basis of statistical probability and non-instantial hypotheses we can also make scientific generalisations. The traditional view that the causal explanation is the defining characteristic of scientific induction, is not fully acceptable.

VALUE :

It is to be noted that the conclusion of scientific induction is never absolutely certain inspite of being supported by the laws. The reliance on the laws only makes the conclusion more reliable or highly probable. There is no question of formal validity in case of any induction what-soever. The laws may constitute strong grounds to establish the conclusion but never prove it .

However, scientific induction is considered by Mill and Bain to be the best form of

induction as its conclusion is more reliable than other forms of induction.

Mill's view of scientific induction is mostly restricted to finding the causal connection. It comes under primary induction. As far as the present day scientific thinking is concerned application of inductive inference procedures to collected data (premises) does not give us scientific knowledge rather the method of inventing hypotheses. By testing them we arrive at scientific knowledge. According to C.G. Hempel, " scientific hypotheses and theories are not derived from observed facts, but invented in order to account for them". Mill's notion of 'induction', in a wider sense, can be used appropriately in case of secondary induction as well.

6.2 INDUCTION BY SIMPLE ENUMERATION :

Induction by simple enumeration is called unscientific induction by some. It is defined as the process of inferring the material truth of a general real proposition from the actual observation of particular instances of facts and phenomena on the ground of uncontradicted experience in reliance on the law of uniformity of nature.

This inference states that in our experience something has been perceived to possess some characteristic. Never have we come across a single contrary instance. Because of the uncontradictoriness of our experience we generalise that all the members of that class possess that particular characteristic. For example, we have found that all the crows are black. We never have come across any non-black crow nor we knew from any other source about a non-black crow. On the basis of such uniformity and uncontradicted experience we come to the general conclusion that "All crows are black"

Example :

Crow A is black

Crow B is black

Crow C is black

No non-black crow is experienced so far.

∴ All crows are black.

The reasoning involved here is :

a_1, a_2, a_3- are p

a_1, a_2, a_3 are all observed instances of a.

No observed instance of a is not P

∴ All a is P

This is the popular form of induction of a common man.

CHARACTERISTICS :

i) Induction by simple enumeration establishes a general real proposition, like scientific induction. "All crows are black" is a general proposition for the subject is about an unlimited number. It is a real proposition as the predicate states a fact about the subject.

ii) Like scientific induction we have the premises of unscientific induction from experience of particular instances. The probability of the conclusion of unscientific induction increases depending upon the number of instances observed under varying circumstances. Thus induction by simple enumeration, as its name suggests, makes its conclusion more probable if more number of positive instances are counted or enumerated for observation.

Induction by simple enumeration is distinguished from induction by complete enumeration. In case of simple enumeration the instances are incomplete as the general proposition is about an unlimited totality. In unscientific induction the observation of particular instances helps us to establish a general proposition on the basis of uncontradictory experience. If we experience one negative instance(contrary instance) like one non-black crow the conclusion is rejected as false.

iii) Like scientific induction there is an inductive leap in unscientific induction. We pass from the known to the unknown, from observed to the unobserved and from particular to general, i.e. some to all.

(iv) Unscientific induction relies on the law of uniformity of nature like scientific induction. But unlike scientific induction it does not rely on the law of causation. We see some uniformity when we mark that all crows are black. We do not know if there is any causal reltion between the colour of the crow with its other essential properties.

VALUE :

We are unaware of any causal relation in case of unscientific induction. In this respect probability of the conclusion of this induction is less than that of the conclusion of scientific induction which is based on causal law.

Logicians, like Bacon, hold that induction by simple enumeration is merely collecting number of instances which is no better than a childish affair. It is the layman's induction. Ordinary people cannot have critical and analytical mind. It may, sometimes, be a complicated procedure to have proper observation of fact. So a common man depends on induction by simple enumeration to arrive at a conclusion. However the common man's popular induction may be, some times, a hasty generalisation without careful examination or scrutiny of the instances experienced. Such generalisations have no probability. But in some other occasions a generalisation has a greater degree of probability. But in general the degree of probability is low in case of induction by simple enumeration due to the risk of a negative(contrary) instance in future. The risk of such a contrary instance ruins the generalisation completely.

It is to be pointed out that the value of induction by simple enumeration is not insignificant in science. It is considered as a beginning stage of scientific induction. As the generalisation is based on uniformity or resemblances of instances it helps us to formulate the hypothesis and thus is the starting point of induction proper.

To sum up, it may be noted that the conclusions of scientific induction and induction by simple enumeration are not different in kind as considered traditionally. The difference is only in degree as both the conclusions are only probable. Hence it is not proper to conclude that scientific induction gives certainty because of its basis of causal law and the conclusion of induction by

simple enumeration gives only probability. As all scientific inductions are not based on casual law and all inductions by simple enumeration are not hasty generalisations their conclusions are more or less probable depending on the circumstance. The conclusions are only different in degree but not in kind so far as their probability is concerned.

6.3 ANALOGY :

The word analogy has been used differently. Logicians use it in different meanings in the context of arguments. Besides its frequent use in arguments it has also literary usage in metaphor and simile by the creative writers to create a vivid impression in the mind of the reader. The literary use of analogy aims at some explanation where something unfamiliar is made easier through a comparison with something familiar with which it has resemblance or similarity. Look at this example

Science is built up with facts as a house is built with stones. But a collection of facts is no more a science than a heap of stones is a house.

This is a literal expression in which science is compared with house and facts with stones. Thus analogy is used both in literary description or in argument. Even sometimes it is difficult to distinguish between a literary use and argumentative use. But we shall not deal with this issue here but see its use in logic.

The argument by analogy has been used right from Aristotle. Aristotle used analogy in the sense of equality of ratios. For example, 3 :6 : :5 :10. Here the relation between 3 and 6 is analogous to the relation between 5 and 10. Whitely defines analogy as resemblance of ratios or relations. Whately's point can be understood by this example :

A is related to B as C is related to D

From the relation of A and B, P follows

$\therefore$ From the relation of C and D P must follow

Carveth Read defines analogy as a kind of probable proof based on imperfect similarity i.e. between the data of comparison and the subject of our inference. Many other logicians like Welton, Mill, Bain, Lotze have discussed analogy in the argumentative sense in their own way

with slight individual variation. All the writers agree on some basic points. That is analogy is a probable inferential process in which two or more things are similar in some respect and one of those things has a further characteristic and from this a conclusion is inferred that other thing also has that characteristic. Precisely analogy is a kind of probable inference from one particular to another based on their resemblance.

It should be mentioned that not every analogical argument needs exactly two things or exactly two or three characteristics. Number and characteristics may vary on which things are similar. The point is not with regard to the numerical differences of number of particulars or number of characteristics. But the general structure used in all analogical arguments is the same. That structure is the defining feature of all analogical inferences. Thus analogy can be defined like this :

"every analogical inference passes from the similarity or resemblance of two or more things in one or more respects to the resemblance of those things in some further respect".

Let us take some examples, symbolic and concrete, to illustrate this point

a, b, c, d have the property P,Q and R

a, b, c have the property S

$\therefore$ d has the property S

In this example a, b, c and d, the individual things, which resemble each other as having the common properties of P, Q and R. It is further observed that a, b and c have the property S. It is not known whether d has the property S or not. But on the basis of its similarity with a, b and c possessing the property S, it is inferred that d has the property S.

Concrete example –

Orissa, Bihar and Madya Pradesh are the states of India having sizeable tribal population. One study reveals that the rate of literacy of tribal women in Orissa and Bihar is within 1 to 2 per cent. So it is reasonable to infer that the rate of literacy of tribal women in Madhya Pradesh would be within 1 to 2 percent.

Thomas Reid's famous example is invariably quoted by writers in different revised forms. According to his original quotation:-

" we may observe a very great similitude between this earth which we inhabit and the other planents, Saturn, Jupiter, Mars, Venus and Mercury. They all revolve round the sun as the earth does, although at different distances and in different periods.

"They borrow all their light from the sun as the earth does. Several of them are known to revolve around their axis like the earth and by that means must have a like succession of day and night. Some of them have moons, that serve to give them light in the absence of the sun, as our moon does to us. They are all, in their motions, subject to the same law of gravitation, as the earth is . From all this similitude, it is not unreasonable to think that those planets may, like our earth, be the habitations of various orders of living creatures. There is some probability in this conclusion from analogy."

Not only in logical arguments in our day today inferences we frequently take the help of analogy. I infer that my new cycle will ride well for my previous cycle which I bought from the same shop and with same brand gave me good ride in the past. When my attention is drawn to a new picture of Dilip Kumar I infer that I shall enjoy seeing it as I have seen his films in the past and have enjoyed them. Those inferences which we mostly use in everyday life are basically analogical in nature.

Analogy has all the basic characteristics of induction. It is based on observation of facts. It collects its premises from experience. On the basic of our experience, this inference is made. But here the conclusion is not a general real proposition unlike that of other forms of induction, but a particular real proposition. Though the conclusion is a particular proposition, a general proposition can implicity be included in it. In the above example I bring all pictures of Dilip Kumar, all cycles of a company under a class to which they belong. Similarly the earth, saturn, jupiter, mars etc. are brought under the class "all planets". But in analogy since we pass from one specific property to another specific property of the same particular or from one specific particular

to another specific particular it is sometimes called an "incomplete induction".

Like other process of induction analogy has a leap. The inferred property has not been observed, so there is a passage from the known to the unknown. In scientific or unscientific induction the leap is with regard to the numerical number of individuals as there we pass from some to all having one property. But the leap in analogy is in respect of the property. Here we pass from one particular case having some properties to the same particular having more properties. Here there is an assumption that properties found together are connected. When we observe some properties in one or some cases, we think that they will be present in other similar cases also. So even if we have not observed a property in one individual we infer it on the basis that property is found in the particular with which that individual has some similarities. If the diffetrent planets have a number of properties in common and the earth is inhabited by living beings, then it is inferred that other planets might be inhabited also.

Analogy has the characteristic of being probable like other forms of inductive argument. The conclusion in scientific induction, unscientific induction or analogy is neither certain nor demonstratively valid. Their conclusions are probable in nature. Probability is a matter of degree. The degree of probability may be high or low depending upon the real situation. In case of some analogical arguments the conclusion is highly probable. Where the conclusion is having higher probability it is called a good analogy and where the degree of probability is less, it is called a bad analogy.

The three characteristics that induction is based on observation of facts, that it involves an inductive leap and that it is probable in nature are found in all forms of induction proper. But in case of scientific induction the generalisation is supposed to be based on an assumed causal connection. According to some text book writers there is no causal relation in analogical induction. While scientific induction is based on a causal relation, analogy lacks any causal relation. But recent writers do not accept this view. They hold that some analogical arguments might be based on causal connection too. Irving M.Copi and Carl Cohen hold that in analogy "one attribute or circumstance is relevant to another for purpose of analogical argument, if the first affects the

second, that is, if it has a causal or determining effect on that other. The factor of relevance is to be explained in terms of causality. In an argument by analogy the relevant analogies are those that deal with causally related attributes of circumstances. Copi and Cohen hold that analogical arguments may be probable whether they go from cause to effect or from effect to cause. They are even probable when the attribute in the premise is neither cause nor effect of the conclusion's attribute, provided that they are effects of the same cause. Thus from the presence of some symptoms of a given disease, a doctor can predict other symptoms-not that either symptom is the cause of the other, but because they are jointly caused by one and the same infection".

So all analogical inferences are not completely free from a causal connection. In some form of analogical argument a causal connection may provide the basis for inference.

Further scientific induction proceeds from particular instances to a general proposition of unrestricted totality. But in analogical argument the conclusion is a particular proposition. That is whereas scientific induction proceeds from particular to general, analogy proceeds from particular to particular. In scientific induction after observing some particular instances we make a generalisation. But in analogical argument some property is inferred to be present with a particular on the basis of its similarity with the particulars who possess this property. Similarity is considered to be the very basis of all inductions. For in scientific induction we observe a, b, c….. have the property p. We find d, e, f.… are similar to a, b, c on some very important points as they belong to one class. Thus we conclude that d, e, f..... and other members of that class to which a, b, c..... belong must have the property p. Hence similarity plays a very important role in making an induction.

When we compare analogy with unscientific induction or induction by simple enumeration we also notice some important resemblances. Both of them involve observation, possess a leap and are probable. But in induction per simple enumeration there is a generalisation on the basis of uncontradictory experience. So the conclusion is a universal proposition with unrestricted generality. But in analogy the conclusion is confined to a particular thing and as such it is a

particular proposition. But the significant point is that in both the ground of inference is resemblance. In unscientific induction a,b,c… who belong to a class are observed to have the property p. d,e,f…. are very much similar to a,b,c… as they all belong to a class. So we infer that d,e,f…which are not observed must have the property p. We find observed crows are black and assume that the unobserved crows are also black because the unobserved crows are very much similar to the observed crows. So the ground of inference or of the generalisation in induction per simple enumeration is this resemblance or similarity. In analogy resemblance or similarity is the very basis of drawing a conclusion. But in spite of these important similarities between induction per simple enumeration and analogy certain striking differences are noticed between them. In the former the evidence for generalilsation is extensive. After observing a large number of instances without a single exception the generalisation is made. So in induction per simple enumeration the extent and number of our observation play the important basis for our generalisation. Therefore in this form of induction the numerical strength of the evidences is of vital importance. But in case of analogical argument the number of instances is not important for there can be an inference even with two things only. In analogy the importance of the resemblance of the properties and their relevance for the conclusion is most warranted. So the emphasis is on the similarity of the properties and their relevance. In other words while in induction per complete enumeration the evidence for the inference is extensive and quantitative in analogy the evidence for the inference is intensive and qualitative. For in the former we go by the number of instances but in the latter we consider the importance and relevance of the qualities on which things are similar.

STRENGTH OR VALUE OF ANALOGY:

Our discussion shows that analogical arguments are not deductively valid. As they are about facts, they are probable in nature. Some analogical arguments are cogent and have a high degree of probability whereas some others are useless and have no importance at all. So there must be some criteria by which the value of an analogy can be assessed. Let us discuss the criteria devised by logicians for the determination of the strength of analogical arguments.

To assess the value of an analogy the number and importance of the points of resemblance

between the particulars are given due weightage. Sometimes the number of instances counts important to add to the probability of the conclusion. Suppose I gave a shirt-cloth to a tailor. Even though he had taken the measurement the shirt did not fit me well. On further occasions other friends also patronise with similar experience that their shirts were not tailored properly to fit them by the same tailor. A number of instances helps draw the conclusion that the tailor does not stitch properly for good fitting. Thus a single instance may not be sufficient to lend support to the conclusion but if a number of instances are there they add to the degree of probability. Of course there is no mathematical ratio between the number of instances and the conclusion. The degree of probability of analogical arguments would be more on the modesty of the conclusion. If my motor-cycle shows less oil consumption and gives high mileage I infer that my friend's motor-cycle which is of the same model and brand would be giving the same mileage.

Further the strength of the analogical inference will be more if the things compared are similar on important and relevant points. Things must resemble on essential points and not on superficial points. A doctor's inference that a will be relieved of his pain by a particular drug as the same drug has relieved the pain of b,c and d having somewhat similar symptoms is a reasonable analogical argument. Because there is similarity in their symptoms and the drug has worked in case of b,c and d, it will be reasonable to think that it will work on a. But suppose p,q and r belong to a particular locality, speak the same language and have the same number of children. It is found that they suffer from stomach-trouble. It will be silly to infer that s who also belongs to the same locality, speak the same language and have the same number of children is having stomach trouble. This argument by analogy is very weak for the points of similarity cited are quite irrelevant to the matter with which the inference is concerned. But in case of the former example the similarities are quite relevant to the conclusion. Thus the strength of the analogy will be more when the points of similarity will be relevant to the conclusion.

From the above illustration it follows that if the points of difference or dissimilarity in analogical argument will be more in number and importance the strength of the analogy will be less. If two things are similar on unimportant or irrelevant points and the point to be inferred has

no useful link with their similarities the probability of the conclusion will be very weak. Suppose two persons belong to the same age group, village, caste and religion. If one is a poet it cannot be inferred that the other person is also a poet. For the conclusion of being a poet has no relevant link with the points of similarity.

Similarly the value of an analogical inference will be less if the unknown sphere between the things compared is larger than their known region. Sometimes our information is inadequate or we are ignorant when we compare two particulars. If we are not sure what are the similarities or dissimilarities between the things then also our conclusion can have less probability. That is if the number and importance of the unknown points will be more then the probability of the conclusion will be weak.

Thus the value of an analogical argument depends on the important points of resemblance between the instance in the premise and that of the conclusion. It is not on how many points the phenomena are similar or dissimilar, but their relevance with the point to be inferred in an analogy is important. The importance of similarity between the instance in the premise and that of the conclusion adds to the probability of the conclusion whereas more disimilarities or the unknown points between the instance mentioned in the premise and the conclusion weaken it and reduce the probability of the conclusion. Some logicians express the value of analogical argument mathematically by means of a fraction in the following manner-

$$\frac{\text{Known points of resemblance}}{\text{Known points of difference} + \text{Unknown points}}$$

In a fraction if the numerator increases, its value increases and if the denominator increases the value of the fraction decreases. Similarly the value of a particular analogical argument is more if the known points of resemblance, the numerator, will be more. That makes the analogical argument more probable. But if the denominator is more, then the value of the argument will be less i.e. the probability will be weak.

But the value of analogy cannot be decided with accurate precision unlike that of a

mathematical fraction. For while a mathematical fraction is constant, the fraction in the analogy is quite uncertain and even vague. Because in the analogy the unknown points always remain uncertain and vague. If some points are unknown, their exact nature and number cannot be determined.

However the value of an analogy mostly depends on the connection between the points of resemblance and the inferred similarity. If the points of resemblance have some determining effect and that is what is inferred in the conclusion, then the value of the analogy would be more.

GOOD AND BAD ANALOGY :

We find that the analogical arguments are probable and not demonstratively valid. The probability of an analogical argument is determined empirically. Observation and experiment determine the merit of an analogical argument. Evaluation renders an analogy as good or bad. A good analogy means where there is higher degree of probability. In such cases there is a close link or determining relation between the data of comparison and the subject of inference. But a bad analogy is a false one for there is no relevant link between the data of comparison and the matter to be inferred. So a bad analogy is very weak. Because in a bad analogy there is resemblance on irrelevant points between the instances of the premise and the conclusion. Some examples will suffice to make the points clear.

1. My neighbour has covered a layer of straw over the roof of his building and that has reduced the temperature of the rooms of his building.

   So I infer that if straw will be covered over the roof of my house, then the room temperature of my house will decrease.

2. I find that my pet dog barks at people who come to my house for the first time as they are stranger to the dog.

   So I infer that if I visit somebody's house and he has a dog, it will bark at me as I am a stranger to the dog.

   These are examples of good analogy as in each case the conclusion is cogent with the premise.

3. In a cricket series when India played with England in each of the two matches it had rained heavily. So it is forecast that it will rain in the third match between India and England to be played after a week.

4. Plants are like human beings for they have growth, decay and death. Human beinigs are intelligent so plants have intelligence.

The above two examples are bad analogies. In the third example the basis of the forecast is two instances of rain during the match between India and England. So from this accidental phenomenon if an inference is made that that will also happen in future there is no cogency between the data of the information and the conclusion. So too in the fourth example human beings and plants are compared to have some similarities. But intelligence of plants does not follow from the points of similarities between plants and human beings.

6.4 PROBABILITY :

We discussed that all inductive arguments are probable in nature. No inductive generalisation is logically certain. Again it was pointed out that probability is a matter of degree. Some generalisaions are highly probable whereas some are less probable. In all forms of proper inductions conclusions are drawn on the basis of some supporting evidences. If the support lent by the premises are most dependable with which the conclusion is characteristically related, then the degree of probability of the conclusion will be high. The probability of the conclusion in inductive argument can be decided on the basis of objective ground. Just as in deductive argument the validity of the conclusion can be decided on objective basis by the help of some criteriological rules, so also in case of inductive argument the probability of the conclusion can be determined objectively by tallying it with the actual state of affairs. An inductive inference is accepted as highly probable if it is coherent with already established generalisations. The frequency of truth of the conclusion is confirmed by experience. The frequency of truth of individual instances increasingly adds to the confirmation of probability of the conclusion. Since the conclusion is a generalised version of the individual instances its degree of probability is high or low depending upon the

frequencies of the supportive evidences. From this it appears that the probability is not an intrinsic or inherent feature of a proposition. It is something extraneous to the proposition. It is because the same proposition might have different degrees of probability depending upon the confirming support or evidence. The relevance of the evidence given in support of a proposition may be different also. The relevance is not the same in all cases. Further the probability of an inductive inference is supposed to be measured by the frequency of the supporting fact. The numerical strength of probability of a conclusion is the adequate evidence for the proposition.

CALCULUS OF PROBABILITY :

Most of the branches of science practically employ the calculus of probability in their studies. The concept of probability is also familiar in mathematics and logic. But propositions of science dealing with matters of fact are different from the propositions of mathematics. So no purely mathematical system can decide the degree of probabilities of assertions of fact. Thus mathematical probability is different from probability used in science. In mathematics the theory of probability is limited to the idea of necessary inference. The idea of mathematical probability connotes the condition of equiprobability of events. The probability of a tossed coin showing head is fifty per cent since a coin has only two sides, such as head and tail. That is when a coin is tossed, either the head or the tail must face upward.

Similarly once the components of a complex event is known the calculus of probability can be determined. The purpose of the calculus is to decide from a complex event the probability of the events comprising it. From a set of alternative possibilities mathematical probability determines the possible consequence of the assumption.

By help of a mathematical ratio the idea of probability is explained. When we are sure that some event will definitely occur its probability is I, and when we are sure of its non-occurrence its probability is O and when our belief is in between the certainty of its occurrence and its non-occurrence the probability is some fraction intermediate between I and O. Further the idea of probability is also linked with the principle of insufficient reason or indifference. That means in a

complex situation of several alternatives, if there is no known reason to accept one rather than another then each of these alternatives has an equal probability. If there is induction, alternatives are equally probable.

Further probability cannot be taken as a measure of belief. For the belief of people about something may remarkably differ. So belief does not always correspond with the state of facts. Hence probability cannot be estimated on the basis of belief. If large number of people believe in something that does not constitute the ground for the belief to be accepted. The belief in astrological prediction or in the existence of ghost by a majority of people cannot be the ground to accept astrology as a science or ghost as a reality.

When calculating the probability of complex events, all possible alternatives are also taken into consideration. The probability of the alternative occurrence of two events is the sum of separate probabilities. Suppose two events cannot occur jointly. In a game of dice 1 and 2 cannot occur together. Since there are six possible values, the probability for each value is 1/6 . So the probability of either 1 or 2 occurring alternatively would be

$$\frac{1}{6}+\frac{1}{6}=\frac{1}{3}.$$

Similarly the probability of the joint occurrence of two independent events is the product of the probability of each of them. If a and b are two separate events, R(a) the probability of the first and R(b) the probability of the second, then the probability of their joint occurrence is R(a) X R(b). Suppose in a winter season a foggy morning occurs in an average of once in four days, and rain occurs once in seven days, their separate probabilities are $\frac{1}{4}$ and $\frac{1}{7}$ respectively in a week. So the probability of their joint occurrence is

$$\frac{1}{4}\times\frac{1}{7}=\frac{1}{28}$$

i.e. the product of their separate probabilities.

TYPES OF PROBABILITY :

In contemporary writings two main theories of probability are found to be discussed. They are the frequency theory of probability and the reasonableness of belief theory of probability. The frequency theory of probability emphasises on statistical evidence. In some sciences like meterology, genetics, biology etc. we mostly rely on statistical evidence. This theory records the frequency with which members of a class exhibit a specified attribute. On the basis of this statistics certain probable assumptions can be made. Suppose 1000 children are randomly selected for case study. It was found that 95% of the children suffered from diahrrhoea when they were below the age of one year. Out of them 2% of children succumbed to death when they suffered from diarrhoea. Again another study showed that out of 1000 tribal children 80 per cent of them had suffered from diarrhoea when they were below the age of one year. Twenty five per cent of the tribal children succumbed to death in diahrrhoea. So the probability of survival of the tribal children suffering from diarrhoea is less than the rate of survival of other non-tribal children. Thus the frequency theory takes account of probability on the basis of statistical investigation. Here the attribution of probability is measured on the basis of relative frequency with which the members of a class show some characteristic feature.

The reasonableness of belief thory of probability holds that between two positions one is worthy of acceptance if it is more reasonable to accept it on the basis of available evidence. Out of two statements compared with a common body of evidences one may be more rational than the other. The theory of evolution is more probable a doctrine than the theory of creation. For the former is more rational and reasonable to be believed. Similarly when modern physics and astronomy had not developed like today and the geocentric theory was the accepted hypothesis the heliocentric theory made a break though in 16th century. The heliocentric theory was found to be more reasonable than the geo-centric one because it could explain more facts than the later.

Sometimes when the numerical value of probability is not known or the evidences at

hand are too inadequate we are guided by sheer guess or vague impressions. The evidence at hand may be very complex and thereby baffling. That reduces the probability of a claim. At times the statistical enumerations can make extravagant claims. Even unscrupulous people deliberately give false figures with a purpose. These negative points reduce probability to chance or chance coincidence. Probability can be linked with chance though there is important difference between them.

When the occurrence of a phenomenon is quite unexpected we call it a matter of chance. Similarly if two events coincide or occur together we treat this coincidence or succession as also due to sheer chance, if no law, causal relation or even probability is traced in the occurrence of the events. That means when there is no ground to infer a phenomenon or there is no uniformity in its occurrence we treat it as a chance-occurrence. But probability is different from chance. The frequency in the occurrence of events, statistical enumerations or reasonableness of a phenomenon on the basis of our cumulative experience helps to ascertain the probability of some circumstance. That is, the probability of a generalisation or inductive inference is not by sheer chance. There is evidential support or source behind them. Either in analogical induction, induction per simple enumeration or legitimate hypothesis there is probability. So while probability is evidence-supporting, a chance is not.

6.5 FAIR SAMPLE :

An inductive inference is probable as it is concerned with the material truth of the conclusion. The truth of the conclusion depends upon the veracity of the premises which act as the basis for the induction. If the conclusion in an induction is a general proposition, it is verified by some sample instances as observation of all instances is not possible. These particular instances should represent the whole class to which they belong. That means the particular instances should be the fair samples of the entire generalised class. Unless the particular evidences are the representative samples, no inductive generalisaion can have higher degree of probability. So the specific problem of induction is to decide to what extent the evidential samples are fair. Hence our attempt to understand the role of fair samples in induction will be of much help to comprehend

the probability of inductive generalisation.

We have already noticed that the theories or laws established in science are basically generalisations. Further the theories or generalisations in every branch of science mutually support one another and make a coherent system. But in the early state of development of sciences the generalisations were considered as somewhat isolated. Even today there are some areas of science-particularly the social sciences- in which generalisations are somewhat isolated from each other and do not constitute a coherent system. Where the theories or laws are mutually supporting they are highly probable forms of generalisaions. But where they are relatively isolated, there the idea of fair sample is very important because on the basis of these instantial representations, generalisations are made. We have already discussed that an inductive generalisation is made on the basis of observation of particular instances. The instances which are observed or verified constitute only a limited or small part of the conclusion which is a proposition of unlimited totality. The more instances covered or verified add to the probability of the conclusion. The problem of inductive leap has been dealt with in the first chapter. Here we shall embark upon on a specific issue of the role of "fair sample" in induction.

It is remarkable that at times a large number of instances is inadequate to establish a generalisaion whereas in some other cases a few instances are sufficient to firmly establish a generalisition. Suppose I have seen some bald-headed people and all of them have crossed fifty. From this I cannot make a generalisation that all bold headed people must have crossed the age of fifty. But observation of a single whale as mammal provides the ground to firmly establish the conclusion that all whales are mammal. Mill has pointed out this problem in a very befitting way in a passage. " why is a single instance, in some cases, sufficient for a complex induction, while in others myriads of concurring instances, without a single exception known or presumed, go such a very little way towards establishing a universal proposition? Whoever can answer this question knows more of the philosophy of logic than the wisest of the scientists, and has solved the problem of induction".

This problem presented by Mill is a problem in philosophy of logic but to find an answer to it is not that difficult or impossible. When a universal proposition is inferred on the basis of our experience of facts, it requires gradual confirmation. Confirmation is made by objectively verifying fair samples. A fair sample must be a representative of the class having all the defining properties with which the class is generally associated. For the observed instance is the representative of all possible instances. Thus any one instance is as good as another. If we find through an experiment the atomic number and weight of silver, then we can comfortably generalise the atomic number and weight of silver. And any object that answers to the definition of silver is supposed to possess the same atomic number and weight like the examined instances. In such case the probability will be too high. Similarly if it is found that frogs collected from different sources are cold-blooded, we become pretty sure that all frogs are cold-blooded because the examined instances are fair samples of all possible instances. In other words the unobserved instances have the same homogeneity with the observed instances. As all frogs make a homogeneous class, so it is not necessary to observe each frog to establish the conclusion. For the verified instances are the fair samples. They represent the whole class. In this example the observed instance is as good as the unobserved or unknown instances. If different instances do not differ in their defining or representative nature, they matter as one instance. Because the members of the class form one homogeneous kind, so to examine a few cases as fair samples will be the basis for generalisation. In some advanced sciences theories or laws established by inductive generalisation mutually support one another and form a coherently organised system of propositions. In some areas a generalisition is not only based on verifying instances of fair samples, but also support some far-reaching results of the system. That means in science each generalisition is not an isolated theory of its kind, rather part of a comprehensive system where theories mutually support each other. For an isolated theory cannot stand firm by itself. Rather as part of a unifying system it supports each generalisation to stand on a firm basis and as such helps the system as well. Thus the probability of an advanced theory is not influenced by further verifying instances but by the supporting theories of the system. But if there is a contrary hypothesis which can systematise the

facts or the prevailing theories in a superior way that poses doubt to the veracity of the prevailing theory in question. So the probability of a theory is influenced by another hypothesis if it has more systematising and explanatory power.

If direct verification of such a theory is not possible, it is verified by random sampling of its consequences. Any non-instantial theory may not be verified directly, but by verifying the sampling of its results its veracity can be accepted provided it has explanatory power.

Thus the idea of fair sample is significant in inductive generalisaions.

6.6 STATISTICAL SYLLOGISM :

We know that syllogism is an argument consisting of two premises and a conclusion. The conclusion puts together the information given in the premises. The syllogism may either be deductive or inductive. The following are some of the examples of deductive syllogism.

Example 1 : All animals are mortal.
All cats are animals.
$\therefore$ All cats are mortal.

Example 2 :

No teachers are uneducated .
Sidhartha is a teacher.
$\therefore$ Sidhartha is not uneducated.
(=it is not the case that Sidhartha is uneducated)

The above mentioned arguments are said to be deductive due to the reason that the conclusion necessarily follows from the premises. The conclusion is certainly true if the premises are true.

Now let us see some examples of syllogism which are inductive.

Example A :

Most of the politicians are corrupt.

Mr X is a politician.

∴ Mr. X is corrupt.

Example B :

Most of the socialists are not rich.

Mr Y is a socialist.

∴ Mr Y is not rich.

Example C :

20% of all men are vegetarians.

Sidhartha is a man.

∴ Sidhartha is vegetarian.

These syllogistic arguments are inductive in the sense that no conclusion necessarily follows. Here even if the premises are true the conclusion is only probable. This argument states that if the premises are true the conclusion is likely to be true. In other words the conclusion is always probable.

An important point of distinction according to some modern logicians (like Salman) is that deductive arguments always use universal propositions(generalisation)whereas inductive arguments often make use of statistical generalisations.

Universal propositions are expressed in the form of: "All S's are P's" (All dogs are mammals) or "No S's are P's" (No crows are white). Statistical generalilsaions state that a proportion of members of one class are members of another class. These proposions are ordinarily expressed in the following forms:

Most S's are P's.

(most of the teachers are learned persons)

Most S's are not P's.

(most of the politicians are not honest)

X% of S's are P's.

20% of politicians are highly educated.

X% of S's are no P's.

95% of scientists are not politicians.

In a statistical syllogistic argument (or a statistical syllogism) one of the premises is a statistical generalisation like the above examples. The other premise is a particular one in the sense that it uniquely denotes one individual. Thus the form of the statistical syllogism is

Example A :

Premise 1 – x% of K's are L's.

Premise 2 – a is a K.

∴ a is an L.

To give a concrete example-

Example B :

80% of students are sincere.

Rabi is a student.

∴ Rabi is sincere.

In the above examples the subject in the first premise (K, student) is called the reference class. This is the class of things or persons to which a characteristic is attributed. The attributed characteristic or property is called the attributive class (L, sincere in the above examples). The subject in the second premise refers to the individual object(person, place, thing etc.) In the above example the individual is a , Rabi(in the two examples respectively). Thus in the above example, the reference class is the class of students, the attributive class is the class of sincere beings and the individual person is Rabi.

It is important to note that the class denoted by K(students) in the first premise includes the individual (Rabi) mentioned in the second premise. This is to say that the individual 'a' (Rabi) in the second premise belongs to the class 'K' (students) of the first premise.

The class denoted by L(sincere beings) in the first premise is the characteristic or property attributed to the individual in the conclusion.

Thus, the statistical syllogism is an argument based on the principle that what is generally, but not universally, true or false of a class is also, in a like manner, true or false a particular instance.

STRENGTH OF STATISTICAL SYLLOGISM :

When we say 100% of 'K's' are 'L's' it expresses a universal general proposition like 'All K's are L' s. The conclusion derived from this premise with the help of the second premise, which is a particular proposition, is certainly true.

In case of statistical syllogism the reference class of the statistical generalisation is not 100%. Hence the strength of the statistical syllogism is judged by the closeness of the members of reference class to 100% having the characteristic of the members of the attributive class. For example, the statistical syllogism,

90% of all men are theists.

Sidhartha is a man,.

$\therefore$ Sidhartha is a theist.

is obviously stronger than the following statistical syllogism.

5% of all girls are vegetarians.

Maya is a girl.

$\therefore$ Maya is vegetarian.

Similarly if the reference class is closer to 0% having the characteristic mentioned in the attributive class of the statistical generalisation, then the individual(in the second premise) is very less likely to possess the property of the members of the attributive class. For example,

2% of the politicians are communists

Sidhartha is a politician.

∴ Sidhartha is not a communist.

We may mark that his statistical syllogism is stronger than the example given below-

40% of the men are bald.

Rahul is a man.

∴ Rahul is bald.

A statistical syllogism may not always have as its first premise of the form x% of K's are L's. In the first premise there may not be given any specific percentage of the reference class. In many cases the words like some, most, almost all, many, usually, few, very few, a few etc. are used to quantify the reference class. It is also not the fact that the argument is always in the present tense.

Look to the following example:

Example A : Most K's are L's.

X is a k.

∴ X is an L.

Example B :

Usually senior students do better than the juniors in games.

Lata is a senior student and Maya is a junior student.

∴ Lata will (probably) do better than maya in games.

Example C :

Few birds are bright coloured.

Sparrows are birds.

∴ Sparrows are not bright coloured.

Sometimes a fallacy occurs in statistical syllogism. The syllogism is fallacious when all

available relevant evidences are not taken into consideration in the first premise. This is called the fallacy of incomplete evidence.

The fallacy of incomplete evidence is committed if and only if some available relevant informations which would reduce the probability of the conclusion are ignored.

For example :

Most intellectuals are not politicians.

The finance minister of India is an intellectual.

$\therefore$ The finance minister of India is not a politician.

The above statistical syllogism commits the fallacy of incomplete evidence by ignoring the relevant information that almost all of the finance ministers of India are intellectuals.

Let us consider another example:

Most of the Oriyas are poor.

The District Magistrate of Cuttack is an Oriya.

$\therefore$ The District Magistrate of Cuttack is poor.

Here the fallacy of incomplete evidence occurs by ignoring the fact that the job of district magistrate is a highly paid job.

Thus by taking note of the available relevant evidences the degree of probability can be assessed. But by ignoring the available evidences the above fallacy will be commited.

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SUMMARY

INDUCTION :

Induction is based on observation of facts and is about the world of facts. It has an inductive leap and it is probable in nature. There are three basic forms of induction such as scientific induction, induction per simple enumeration(or unscientific induction) and analogy.

SCIENTIFIC INDUCTION :

In scientific induction the conclusion seeks to establish a general real proposition. It is based on observation or experiment of facts.

It involve an inductive leap.

It is usually founded on uniformity of nature and law of causation.

It is probable in nature.

INDUCTION PER SIMPLE ENUMERATION :

Its main characteristics are

a) It is based on uncontradictory experience

b) It establishes a general real proposition

c) It has an inductive leap

d) It does not rely on the law of causation

ANALOGY :

Analogy is a kind of probable inference from one particular to another particular based on their resemblance. Its main characteristics are

a) It is based on observation of facts

b) It has inductive leap

c) It is probable

The strength of an analogy depends on the number and importance of the points of resemblance of the particulars.

On the basis of this an analogy may be good or bad.

PROBABILITY :

Inductive generalisations are probable. Mathematical probability is different from the probablity used in science.

Sometimes the idea of probability is explained by mathematical ratio. Probability cannot be estimated on the basis of belief. While calculating the probability of complex events, all possible alternatives are considered. There are two theories of probability such as the frequency theory of probability and the reasonableness theory of probability.

An unexpected occurrence of a phenomenon is termed as chance.

Probability is evidence-supporting but chance is not.

FAIR SAMPLE :

A fair sample is the representative individual of a homogeneous class having all the defining characteristics of that class. So any one instance is as good as another belonging to the same class.

A scientific generalisation is not an isolated theory rather part of a coherent system in which theories mutually support one another.

STATISTICAL SYLLOGISM :

In a statistical syllogism the conclusion does not necessarily follow from the premises. It is inductive rather than deductive

One premise here is a statistical generalisation. The conclusion is probable. The probability of the conclusion depends upon the strength of the attributive class.

MODEL QUESTIONS

GROUP - A

Objective Questions :

1. Answer the followiong :

a) How many kinds of induction proper are there ?

b) Name the different kinds of processes simulating induction.

c) Which induction is the best form of induction ?

d) Define unscientific induction

e) What is the important characteristics that unscientific induction lacks ?

f) Give an example of a good analogy.

g) Give an example of a bad analogy.

h) What are the different theories of probability?

i) Give an example of inductive syllogism?

j) What is the nature of the premises in a statistical syllogism?

k) What is a fair sample?

2. Name the process of reasoning involved to make each of the following statements :

a) Where there is smoke, there is fire.

b) All lions are carnivorous.

c) Plants must have life as they grow and die.

d) Radhakrishnan is a vegetarian as most of the South Indians are vegetarians.

3. Fill in the blanks :

a) Inductive leap is an important characteristic in all forms of induction ———.

b) Leap means a———— from some to all.

c) Analogy is based on ————.

d) ——— induction is an induction par excellence.

e) Unscientific induction is otherwise called induction per simple ———.

f) In a fair sample the members of a class form one _____ kind.

g) In a statistical syllogism the subject is called _____ class.

GROUP - B

Short type Questions :

1. Explain the following

a) What is an inductive leap ?

b) What is inductive per simple enumeration ?

c) Illustrate a bad analogy?

d) What does the strength of an analogy mean ?

e) What are the forms of reasoning that establish a general proposition in the conclusion ?

f) What is calculus of probability?

g) Can probability be estimated on the basis of belief.

h) How is the problem of induction related with the question of fair sample?

i) Why is a theory in science not an isolated generalisation.

j) What does the strength of a statistical syllogism mean?

GROUP - C

Long type Questions :

1. State and explain the characteristics of induction
2. What is unscientific induction ? How is it different from scientific induction ?
3. What is analogy ? Discuss its different forms with suitable examples.
4. Explain analogy as a form of induction proper. How is its strength determined ?
5. State and explain the different views of Probability.
6. What is statistical syllogism ? Is it deductive or inductive in nature ? Discuss.
7. What is the significance of fair sample in inductive generalisation ? Discuss.

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CHAPTER - 7

FORMAL GROUNDS OF INDUCTION

Introduction :-

Man is not always satisfied with particular facts like this piece of iron rusts when exposed to oxygen, or in the falling of a particular stone to the ground, or in the death of a particular man etc. He is eager to generalise. He wants to arrive at a general proposition on the basis of some particular facts that he has actually observed. Thus after observing a few cases of falling of stones when thrown upward, rusting of iron when exposed to air etc. he is tempted to generalise. He arrives at general propositions like all material bodies fall to the ground when thrown upward, iron rusts when exposed to oxygen, etc. But this is not to say that all the generalisations that he makes are genuine and acceptable scientifically. Generalisations like 'all mangoes are sweet', 'all men are honest', 'all cows are white' are not genuine ones for the reason that in such cases there is every chance of meeting some contrary experiences. We may find some mangoes which are not sweet, some cows which are not white etc. So these generalisations are not acceptable. Thus there are generalisations, like the former ones, where we never come across any contrary instance. Even the possibility of getting one is also very remote. Such generalisations are highly probable or almost certain. These generalisations of unrestricted totality are strongly supported by two laws or principles namely, the law of uniformity of nature and the law of causation.

The law of uniformity of nature holds that the same cause will produce the same effect under similar circumstances while the law of causation states that every event has a cause. On the basis of the law of causation a causal connection is established between two events and then a generalisation is made on the ground of uniformity of nature. Both the laws are somewhat indispensable for inductive generalisation. In other words without their supports inductive generalisations will be very weak. They justify our leap from some cases to all cases, from known cases to unknown cases etc. That is why the law of causation and the law of uniformmity

of nature are called the formal grounds of induction. But it should be mentioned that inductive arguments are not at all formally valid. Formal validity is a typical characteristic of deductive inference.

In short in induction we seek to establish general propositions on the basis of observation of particular facts. But what is the basis of such generalisations? How can the problem of induction be met? That means how can inductive leap be explained? The basis of inductive generalisation, according to Mill, is the above mentioned two laws namely the Law of Uniformity of Nature and the Law of Causation. These two laws are termed as the formal grounds of induction.

7.1 THE LAW OF UNIFORMITY OF NATURE :

The law of uniformity of nature is one of the two formal grounds of induction. It is, according to Mill, a fundamental principle of knowledge. This law has been variously described. It is said -nature behaves in the same way under similar conditions, nature is uniform, in nature there are parallel cases, the future is like the present, nature repeats itself, the future resembles the past, nature is governed by laws, the same cause will produce the same effect, etc. For example, timber is found to float on the surface of water in the past. So we infer that it shall continue to float in water in future also in similar conditions. Similarly since water has quenched our thirst in the past, it shall continue to do so in the future under similar circumstances. Again if quinine has cured malarial fever in the past, it shall have the same effect in the future under similar circumstances. In other words if something is true of some members of a class, it will be true of all members of the class under similar conditions. In short, nature is law binding and it is uniform. Violation of law of nature is not known. It is empirically impossible. For nature never acts irregularly.

It should be pointed out here that the law of uniformity of nature never denies variety in nature. On the other hand it admits of infinite varieties of phenomena in nature. But due to the presence of infinite varieties of phenomena in nature some wrongly hold that nature is not always uniform. On the other hand it is full of surprises. It is thus said, "In many ways nature seems not to be uniform, there is a great variety in sizes, shapes, colours and all other properties of things".

In like manner Mill says, "Nobody believes that the succession of rain and fine weather will be the same in every future year as in the present. Nobody expects to have the same dreams repeated every might". And such arguments fail to disprove the uniformity of nature. Despite varieties nature certainly remains uniform. For what the law of uniformity of nature asserts is that all varieties of nature are subject to uniform laws. Each one of them depends on certain cause and when this particular cause recurs it also reappears. Thus for example if the cause which was responsible for creating a total solar eclipse in the past is repeated, then total solar eclipse will also recur. In the same way if the cause which was responsible for creating headache in a person in the past is repeated today, then the person will again suffer from headache. So all the infinite varieties of phenomena in nature are subject to their respective laws. Nothing in nature is accidental or groundless. Nature admits of no lawlessness. Instead law reigns supreme in nature. There is rule of law everywhere in nature.

One can assume from the above that there is not one uniformity or law governing the entire nature. For diverse events are systematised under different departments. Different departments of nature act uniformity in accordance with their respective laws. That is to say corresponding to different departments of nature there are different departments of science to study or investigate their respective subject matter as per certain laws. These laws are uniformly operating in different departments of nature. Thus for example the heavenly bodies like stars and planets are governed by the laws of astronomy; matter, energy and physical events are governed by the laws of physics; human beings act in accordance with the laws of psychology etc. Likewise plants are governed by the laws of botany, elements, atoms etc. are governed by the laws of chemistry and so on. In each department definite laws or uniformities are operating and so it is maintained that there is not one uniformity but corresponding to different spheres of nature there are several uniformities or laws. Bain, therefore, holds "the course of the world is not a uniformity but uniformities".

But such a view is not tenable on the ground that even though there are many uniformities or laws governing the different departments of nature yet there is an underlying unity among them because nature as a whole behaves uniformly. The different spheres of nature are but parts of one system. In this sense it is still better to call it unity of nature. Mill who is an empiricist believes

that we establish the general law of uniformity of nature after observing or experiencing particular cases of uniformities. From our experience we know that timber floats in water, water quenches our thirst, water flows downward and since we never come across a single exception to contradict our above experiences we are led to believe that nature as a whole is uniform.

PARADOX OF INDUCTION:

The law of uniformity of nature is a formal ground of induction according to Mill and others. It is the foundation or the basis of all inductive generalisations. Unless we believe this principle we cannot pass from some to all, known to unknown, from past to present and then to distant and unknown future. In other words the law justifies or guarantees the leap from particular cases to a general law. Neither can we generalise nor can our generalisation be proper unless we believe that nature will behave in the same way under similar circumstances. This law, therefore, is the very basis or ground of induction.

But quite contrary to this above view Mill also held that the law of uniformity of nature is the result of induction. Even he called it the result of induction per simple enumeration. Induction is justified by the law of uniformity of nature. But the law of uniformity of nature itself is the result of induction per simple enumeration. In other words from experience we gather cases of particular uniformities like fire always accompanies smoke, water flows downwards, magnets attract iron and so on. Since we do not come across any contrary experience we are gradually led to believe that everywhere in nature things behave in uniform manner, or nature, as a whole, is uniform. This uncontradicted experience of ours gathered year after year forms the very basis of our understanding of nature. In short, according to Mill the law of uniformity of nature is the result of induction per simple enumeration. This is the manner in which the law of uniformity of nature is established as the ground of induction.

So for Mill what is the ground or foundation of induction is also the result of induction. This is known as the paradox of induction. But Mill's paradox of induction is subject to criticism for the following reasons-

First, Mill's argument involves the fallacy of petitio principii because he argues in a circular way. He says that the principle of uniformity of nature is the ultimate basis; the major premise

of all inductive genrealisations and again he says that this principle is the result or conclusion of induction. But can the uniformity of nature be the major premise and conclusion at the same time? If it is the ground or very basis of induction it cannot be its result at the same time. Mill is trying to prove uniformity of nature by induction and again he is trying to prove induction by uniformity of nature. This is like proving A by B and B by A. But this is not tenable for he is arguing in a circular manner. He assumes the law and again tries to prove it.

Secondly according to Mill the conclusion of induction per simple enumeration has lesser degree of probability. If the principle of uniformity of nature be the result of induction per simple enumeration it will have less probability too. In that case it cannot be the basis of all inductions. But in scientific induction the conclusion has a higher degree of probability. What is less probable cannot be the basis of what is highly probable. Thus uniformity of nature cannot be reduced to a form of induction per simple enumeration. Since it is the basis of all inductions, it itself cannot be reduced to a form of induction. Certainty can be the basis of probability, but probability cannot form the basis of certainty.

Mill, as an empiricist, accepts the law of uniformity of nature as an empirically derived assumption. His problem is that he takes induction, particularly scientific induction, as absolutely certain. An absolutely certain generalisation cannot be founded on an empirically derived assumption, that too which is a product of induction per simple enumeration. So he tries to make the law of uniformity of nature as the major premise of all inductions and draws generalisations from it to make induction as absolutely certain. He seeks logical or formal certainty in case of induction. That means to provide analytical or formal certainty to scientific induction he seeks justfication for the law of uniformity of nature on the basis of experience of facts. That leads him to fall to the problem of paradox of induction.

But any generalisation, even scientific generalisation, cannot enjoy formal certainty for inductions are about facts of the world. Any proposition that enjoys formal or analytical certainty cannot have factual significance. Any factually significant assertion cannot enjoy logical, formal or analytical certainty. To mix formal certainty with factual certainty is a conceptual confusion.

Further in case of factual certainty there are also differences. The statement that at present

there are thirty districts in the state of Odisha is a particular proposition whose truth can be conclusively ascertained by verification. In case of particular propositions, its truth or falsity can be ascertained by verification with the help of observation or experiment of facts. But a general proposition like all material bodies gravitate, no crow is a mammal etc. is a generalisation with unlimited numbers. Such propositions can have probability but not certainty. Since we have verified such cases under numerous and varied situations we accept them beyond doubt as uniform occurrences. But such generalisations cannot enjoy formal or analytical certainty, for no factually siginificant proposition possesses it.

Mill's confusion of two stands leaves him in a paradoxical position. But a paradox is an absurd position somewhat self-contradictory or self-defeating. Mill as an empiricist tries to find justification for the law of uniformity of nature and has taken experience as its basis. He, therefore, infers it like an induction. On the other hand he ascribes analytical certainty to induction thereby making the law of uniformity of nature as the major premise of all inductions. For if it would be the ultimate major premise of all inductions, generalisations thereby can be absolutely certain. So he falls to a perplexing position by making the law of uniformity of nature as the basis of induction and the law as a product of induction. But in fact no paradox would be there once it is understood that inductive generalisations are factually true and cannot, unlike analytical propositions, enjoy absolute certainty.

Thus it is absurd to accept the law of uniformity of nature as the ground of all inductions and again make itself a result of induction. But this paradox can easily be avoided. For if the law of uniformity of nature be taken as the ground of all inductions, the empiricist position that the law of uniformity of nature is the result of an inductive procedure should be given up. And if the law will be taken as a result of induction per simple enumeration, then the idea that it is the ultimate ground of all inductions should be abandoned.

7.2 THE LAW OF CAUSATION :

It has been pointed out earlier that the law of uniformity of nature and the law of causation constitute the formal ground of induction. Mill says that a principle of unimormity of nature is the formal ground of all inductions. For the leap from the known to the unknown, some to all is made

possible by the presupposition of the law of uniformity of nature. In case of scientific induction both the principles of causation and uniformity of nature form the formal ground of indcution. By means of law of causation a causal connection is first established between two events. But to generalise or extend this result further under the impression that the same cause will produce the same effect under similar circumstances we must seek the help of the principle of uniformity of nature. Law of causation is the discovery of a causal relationship between two events, states, processes or phenomena. But in order to arrive at a general proposition we need the help of the law of uniformity of nature. Thus for instance while to ascertain a causal connection between gravitation and falling of a particular stone to ground we need the law of uniformity of nature to establish the general proposition "all material bodies fall to the ground because of gravitation".

In the conclusion it can be said that whereas the law of uniformity of nature is the ground of all forms of induction to bridge the gap of inductive leap the law of causation forms the basis of scientific induction. But both the laws constitute the formal ground of induction.

SUMMARY

Uniformity of Nature :

According to Mill the law of uniformity of nature is a formal ground of induction. It maintains that the same cause will produce the same effect under similar circumstances.

It also means nature behaves uniformly under similar circumstances.

There are different spheres of nature and each sphere is governed by uniform laws or regularities. The different laws or regularities constitute one system that we call nature. So nature is unity in diversity.

When Mill reduces uniformity of nature to a form of induction there arises a paradox. Once the ground of induction is reduced to a form of induction, there will arise the fallacy of petitio prinicipii and other difficulties.

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MODEL QUESTION

GROUP – A

Objective Questions

1.a. What are the formal grounds of induction?

b. State the law of uniformity of nature.

2. Fill in the blanks :

a. Law of uniformity of nature is _____ ground of induction. (formal, informal, material)

b. Law of causation is _____ ground of induction. (experimental, formal, material)

c. _____ is justified by the Law of unifromity of nature.
(analogy, inductiveleap, unscientific induction)

d. _____ holds the opinion that "the course of the world is not an uniformity but uniformities. (Mili, Bain, Read)

3. Distinguish between :

Uniformity of nature and unity of nature.

Factual certainty and analytical certainty.

4. Write short answers :

a. What is the paradox of induction?

b. What is variety in nature?

5. Questions for long answers :

a. Discuss what is meant by the law of uniformity of nature.

b. What is paradox of induction? How can this paradox be solved?

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CHAPTER-8
LAW OF CAUSATION

Introduction :-

The word "cause" is used in every day life as well as in science. The laymen uses the idea of cause to have an immediate answer to some problem. For him what makes a thing occur is the cause and what is made to occur due to something is the effect. When there is some event or action, man wants to known the doer or the agent of that action. Sometimes he also seeks an explanation about how something has happened. To know the agent or the process of an action is considered to know its cause. In science it is somewhat a fundamental axiom that everything that occurs in nature does not just occur. Whatever occurs in nature, occurs only under some condition. To find out the cause of a phenomenon is to know the conditions that lead to its occurrence.

Either in Science or in common sense, the law of causation states that every event has a cause. The occurrence of everything is due to or on account of a cause. Whatever happens has a cause. In the words of Mill "Every phenomenon which has a beginning must have a cause". Bain in the like manner says, "Every event that happens is definitely connected with some prior event, which happening, it happens and which failing, it fails". It means whatever phenomenon happens is definitely connected with some prior event. The presence of this prior event causes the occurrence or happening of the phenomenon and its absence to its non-occurrence. The presence of some prior event is indispensable for the occurrence of a new phenomenon because there cannot be any beginning out of nothing. "Ex nihilo nihil fit" which means nothing comes out of nothing. Bain therefore rightly observes "no change arises out of vacuity or stillness"

8.1 CONCEPT OF CAUSE:

The idea of cause has been construed differently by different philosophers. There is also a popular as well as a scientific view of causation. The popular view of cause in many cases is partial and sometimes even superstitious. Causation is also an important concept in scientific explanation. The scientific view of cause as it was held in the past has undergone revision in modern science. Keeping all these facts in view we shall discuss some commonly accepted characteristics of causation.

i) Causal relation holds between pair of events on the basis of our experience. Causal connection is discovered empirically. A causal relation is that a given phenomenon is uniformly and invariably attended by another phenomenon. We experience, either through observation or through experiment, regular association of one kind of phenomena with another kind of circumstance. On the basis of this observation we establish a causal connection between pairs of phenomena.

We find that fire is invariably associated with smoke or water freezes and solidfies when temperature becomes zero degree or less. This characteristic behaviour of phenomena gives the idea of a causal relation between pairs of events. Since we uniformly observe fire to be associated with smoke we take fire to be the cause of smoke. In case of a causal connection when we observe one phenomenon, we expect to find the other. When we observe smoke we expect fire to be there.

ii) Cause always precedes the effect. Causal relation between two phenomenon is a temporal relation. There is invariable succession between two events which are causally connected. Even there can be simultaneous causation. But under no circumstance the effect can precede the cause nor can the cause follow the effect. Sometimes there can be co-effects of a single cause also.

iii) Cause and effect are relative concepts. A phenomenon can be the cause in relation to its invariably following event, the effect, and the effect in relation to its invariably preceding phenomenon, the cause. Flood can be the effect of excessive continuous rain. Thus in this example

continuous rain is the cause and flood is the effect. But flood can be the cause of crop failure. If there is failure of crops due to flood, then flood can be taken as its cause. Hence there is no phenomenon which is an absolute cause.

iv) Cause can be taken as the necessary and sufficient condition for the occurrence of the effect. But the word "cause" is sometimes used either in the sense of necessary condition or sufficient condition. So it is useful to know the difference between the two concepts. A necessary condition is the circumstance in absence of which the effect cannot occur. A sufficient condition is a circumstance in whose presence the effect must take place. For example, oxygen is a necessary condition for the occurrence of combustion, for without it combustion cannot take place. But it is not a sufficient condition for oxygen may be present without combustion occurring. Failure of heart is a sufficient condition for the death of a person. For if someone's heart stops functioning then that is sufficient for the death of the person.

v) Causation is an empirical relation but not a logical implication. If it is said that there is a causal connection between two events C_1 and C_2, say, for example, between mosquito-bite and malaria it does not mean that C_2 necessarily follows from C_1. Rather their relation is discovered after a lot of scientific investigation. So causal connection between two events is inductively established on the basis of experience, either by observation or experiment. Hence causal relation is a posteriori but not a priori. After repeated observation of the invariant association between two phenomena and after discovering their characteristic connection, a causal relation between them is established. So the effect does not logically follow from the cause but empirically and inductively associated with the cause.

vi) Causal connection is not a relation between two isolated events, but there is generality in such a relation. Two events to be causally connected means they are generally and uniformly connected. That means each occurrence of an event being produced from a cause is a simple instance of a causal law which is a general principle. That general principle holds that such circumstances always follow from such phenomenon.

If I put my finger on fire and get hot-sensation it is not a single case of this sort. But it is

an instance of the causal connection that fire, when touched, gives hot sensation. That means there is a general causal relation between fire and hot sensation. It signifies that this relation is an invariant one for it will happen at any time, at any place and to any person. This generality between two events as cause and effect is the result of the law of uniformity of nature.

ARISTOTLE'S VIEW OF CAUSATION :

Aristotle viewed cause from a wider perspective. A cause for Aristotle is not simple but compound in nature consisting mainly of four factors. Besides, such factors are not interdependent in the production of the effect. On the other hand each of the four factors has the legitimacy to be treated as a cause by itself. So Aristotle virtually believes in four kinds of causes, namely I) material cause ii) formal cause iii) efficient cause, and iv) final cause.

Material cause of a thing is the matter or the substance out of which the effect is produced. Thus for example, cement, sand, bricks etc. constitute the material cause of a building. The building is constructed out of these materials. So sand, cement, brick etc. form the material cause of the building.

Formal cause of an effect means the new shape or the form that is given on the substance for the production of an object or effect. Clay is materially necessary for creating a utensil, say a pot, a statue or a brick. So it is on this clay that the form of a pot, or of a statue or of a brick is imposed. So the form of the statue is formal cause for without it the clay would have remained as clay only.

Efficient cause is the skill or the energy necessary for producing the effect. The cement, bricks etc. cannot take the form of a building. It is the skill or the brain of the architect that has created a Konark or a building. The agent who applies the form to the material is the efficient cause. In making a gold-ring, the maker is the efficient cause, the form of the ring is the formal cause, gold is the material cause.

The final cause of a thing is the very purpose for which the change is brought in. The purpose behind the production of the effect is the final cause of the thing. The very idea or

purpose for which the entire project has been taken in is considered to be the final cause. The purpose behind the making of a gold-ring is to wear it in a finger. This purpose is the final cause.

It is to be noted in this regard that the formal and the material causes are intrinsic in nature as they are very much present in the constitution of the thing in question. But the eficient and the final causes are extrinsic in nature as they are external to the concerned thing.

8.2 CAUSE AND CONDITION :

The cause is not something very simple to be known. Rather it is so complex that it requires a lot of investigation to be known. It may be analysed into several condition. It is considered by some as the sum total of all conditions. Conditions are classed as positive and negative. Thus the positive conditions and the negative conditions taken together constitute the idea of cause. Accordingly a positive condition is one that cannot be omitted and a negative condition is one that cannot be introduced for the occurrence of the effect. In short positive conditions must be present and negative conditions must be absent if the effect is to be produced. Negatively speaking the effect cannot be produced if the positive conditions are absent and the negative conditions are present. For example if a man fell down from the top of a tree and later on died the positive conditions for his death would be the height from which he fell, the nature of the ground on which he fell, the parts of the body that dashed against the ground, the stroke he received etc. Similarly the negative conditions would be some support on the ground, immediate medical help, resistance of the person to sustain a stroke etc. Like wise if a student secures the first position in HSC examination the positive conditions are his preparations, intelligence, clarity, favorable questions, proper valuation etc. whereas the negative conditions are erratic valuation, bad health at the time of examination, too much of mental tension etc.

A positive condition is thus a necessary factor of a cause. There may be different factors as well. Science treats all the necessary conditions and their invariability for the occurrence of the effect. Effect too also consists of conditions. So a set of invariable conditions called the cause gives rise to succession of other conditions called the effect.

In science all conditions which are necessary and sufficient are listed in the idea of a cause. Scientifically the relation between cause and condition is analogous to the relation between the whole and the parts. Conditions taken together constitute the cause. Cause stands for the whole and conditions are its different components. In order that the effect will be produced all the positive conditions work to give rise to the effect. Mill too says "the cause is the sum total of all conditions, positive and negative taken together.

It is to be mentioned in this connection that it is not possible to know all the negative conditions. That is why a negative condition is described as the absence of all preventing circumstances. Those circumstances that prevent the occurrence of the effect are the negative conditions. In a circumstance the number of the negative conditions may far exceed the positive conditions. As they are too many it is not that easy to list all of them. But if in presence of the positive conditions the effect does not occur, then the preventing circumstance that stands on the way is investigated. Science takes note of the preventing factors and treats them as negative conditions.

But a common man does not distinguish between the necessary conditions and the preventing conditions. Sometimes an important condition or a striking factor is regarded as the whole cause. Even at times a negative condition is considered as the cause of a phenomenon overlooking the positive conditions. These are considerations of a popular mind. But in scientific analysis all conditions are explained to give a vivid description of what the cause of a phenomenon or of a class of phenomena is.

NECESSARY AND SUFFICIENT CONDITION :

We have already mentioned in this chapter the idea of necessary condition and sufficient condition in the context of concept of cause. Sometimes "cause" is used in the sense of necessary condition and sometimes in the sense of sufficient condition. But these ideas - necessary condition and sufficient condition--are different from each other though both are conditions for the occurrence of an event. A necessary condition for the occurrence of an event is a circumstance in whose absence the event cannot occur. While investigating the cause of a disease if a particular germ is

detected, the germ is taken as the necessary condition, for in its absence the disease cannot occur. For admission into a +2 college passing of HSC examination or its equivalent examination is a necessary condition for without it one is not eligible for admission into a college. But a sufficient condition for the occurrence of an event is a circumstance in whose presence the event must occur. If an event has several necessary conditions they must be included in the sufficient condition. In the above example passing of HSC examination is a necessary condition for admission in to a college but securing the requisite mark on merit selection is a sufficient condition for admission. But sufficient condition is regarded as the combination of all necessary conditions.

Further when an effect is present and the cause is to be inferred or investigated, there the necessary condition is sought for. But when the effect is to be inferred from the cause, the sufficient condition is sought. That means cause is identified with either necessary condition or sufficient condition depending upon the context.

REMOTE CAUSE AND PROXIMATE CAUSE :

In s causal sequence there are several events connected like a chain. In such a case a proximate cause can be distinguished from a remote cause. Suppose in a causal series A causes B, B causes C, C causes D. Here D is the direct effect of C, but it is the result of all the preceding events such as A,B and C. In this example C is the proximate cause of D whereas A and B are the remote causes of D. If there is deforestation, it creates ecological imbalance. From ecological imbalance the atmospheric temperature increases. That results in melting of ice shelf in south pole of Antarctica. This increases water level in the oceans and sea. Consequently low level land areas will be submerged in water. Thus the immediate preceding cause of an event is its proximate cause whereas the other causes in the causal sequence are the remote causes.

8.3 QUALITATIVE AND QUANTITATIVE MARKS OF CAUSATION :

Mill takes cause as the sum total of conditions, positive and negative taken together. Bain falls in line with Mill when he defines cause as the entire aggregate of conditions or circumstances requisite to the effect. Carveth Read attempts to give a scientific account of causation by bringing

out its qualitative and quantitative aspects. According to him qualitatively cause is "the immediate, unconditional, invariable antecedent of the effect" and quantitatively cause is "equal to the effect".

Let us first discuss the qualitative marks of cause as pointed out above.

i) Cause and effect are relative terms. No one should be under the impression that cause and effect are two distinct water-tight compartments. That is to say it is a mistake to believe that there is a group of phenomena which are causes and another group which are effects. On the other hand cause and effect are relative terms in as much as one and the same event may be a cause in relation to its effect and also be an effect in relation to its cause. Thus for example while rain is the cause of wet-ground, it is also the effect of monsoon cloud.

ii) The given phenomenon is an event in time. It is a matter of common experience that things change constantly. Changes in nature occur ceaselessly. Without such changes the problem of causation will not arise. It is inherent in man to ask for the cause of such changes. Man seeks to know the cause behind the various phenomena that take place in nature. When some phenomena occur, the existing order of things changes. Man's intellectual need is to ask for the cause of such changes.

iii) The cause is an antecedent of the effect. Causal relation is a temporal relation. That means causation involves succession in time. Cause always precedes the effect and the effect always follows the cause. Cause is, therefore, the antecedent of the effect. Mosquito bite precedes malarial fever. So malarial fever is the effect and mosquito bite is the cause which precedes the former.

But this view that cause is the antecedent of effect is objected by some logicians. For they hold that cause and effect are relative ideas. An event cannot be called a cause by itself unless it is associated with another event called the effect. That means if cause is an antecedent and effect is a consequent how can causation be applied to them as one is existing and the other is non-existing at a particular time. So they treat cause and effect as simultaneous events.

But again if two event take place simultaneously it is arbitrary to choose one of them as cause and the other as effect.

It is to be remembered that although cause and effect are quite distinct in nature, their distinctness is marked by a line similar to mathematical lines which just exist in our mind but not in reality. That is to say nature is one continuous process, so no sharp line of demarcation is there between cause and effect according to Mellone. According to him nature is a continuous process and what we call cause or effect is nothing but different factors. So it is not that easy to mark off one from the other.

iv) The cause is an invariable antecedent. Cause no doubt is an antecedent but each and every antecedent is not to be taken as cause. Cause is an invariable antecedent. Antecedent can be variable or invariable. Variable antecedents cannot be treated to be cause because they sometimes precede the effect and sometimes do not. Hooting of an owl might be there prior to the death of a great man. But it is not to be considered as the cause. For there are several instances of death without prior hooting of the owl. Likewise appearance of a comet in the sky is sometimes blindly believed to be the cause of death of some great men. But this too is not the cause of death of a great man. For many other great men have died in the past even though no comet was seen in the sky. In other words hooting of the owl and appearance of comet are variable antecedents and they have no characteristic relation with the death of a man. A variable antecedent is not the cause of an event. Invariable antecedents are those that invariably precede their respective effects. So invariable antecedents are alone fit enough to be called causes. For instance heart failure is the invariable antecedent of the consequent, death, because it always precedes death.

Thus only invariable antecedent of a phenomenon can be entitled to be the cause. But to take any antecedent to be the cause will lead to the fallacy of post hoc ergo propter hoc. This fallacy literally means after this, therefore because of this. Before the death of a great leader, there may be many antecedent phenomena like hooting of an owl, appearance of a comet,

cyclone in some part etc., but they are not the causes. If any and every antecedent of a phenomenon is taken as the cause there arises the fallacy of post hoc ergo popter hoc. Because they are not invariable antecedents. On the other hand the cause is an invariable antecedent, because without such an antecedent the effect does not occur.

v) The cause is the unconditional antecedent. All causes are invariable antecedents but not vice versa. Cause is not only the invariable but also the unconditional antecedent. For if cause were only invariable antecedent that would land us in the embarrassing position of saying day is the cause of night or for that matter night is the cause of day. For day invariably precedes night and night too invariably precedes day. But none of them can be called the cause of the other. The reason is that day cannot independently cause night nor can night independently cause day. For each of them to produce the other depends on a number of conditions like rotation of the earth round the sun, light of the sun, position of the earth etc. So here the invariable relation of day and night is conditional or dependent on a number of extraneous conditions as mentioned above. So none of them can be the cause of the other, on the other hand both are coeffects. But the cause without depending on any other extraneous condition must be able to produce the effect single-handedly. In short it must be the sole sufficient agent to produce the effect. In other words the cause must not only be invariable but also the unconditional antecedent. Bain therefore very appropriately suggests that cause is the "sole sufficing circumstance whose presence makes the effect and whose obsence arrests it". To Mill an unconditional antecedent is that group of conditions which without any further condition helps the event in question to occur.

vi) The cause is the immediate antecedent. The immediacy of the cause follows from its unconditionality. Failing to produce the effect single handedly if the cause depends on some other factor for the occurrence of the effect, it will be dependent on that factor and hence cannot be unconditional. So the cause has to be the immediate antecedent and there must not be any intervening factor behind it and its effect. Thus for example when a bullet is fired, the wall collapsed and the man standing behind it is killed. Here firing of the bullet is the remote cause but collapse of the wall is the proximate cause of the death of the man. For had the wall not collapsed

he would not have died despite the firing of the bullet. In a situation if A causes B, B causes C and C causes D, then C is the immediate cause or the proximate cause of D whereas A or B is the remote cause of D. Thus the cause is the immediate antecedent but not the remote antecedent. The immediate antecedent is the proximate cause that immediately gives rise to the effect. But a remote cause gives rise to the effect in a remote way.

QUANTITATIVE MARK OF CAUSATION :

According to Carveth Read so far as matter and energy are concerned there is a quantitative equality or agreement between the cause and the affect. In other words quantitatively matter and energy in the cause are equal to it in the effect. This is obvious for the reason that the effect is not altogether a new product. Instead it is only transformation of the cause. This quantitative equivalence of the cause and effect is based on the laws of conservation of matter and conservation of energy.

The law of conservation of matter states that the total quantity of matter in the world neither increases nor decreases, it remains constant or unchanged. The form of matter only changes but not its quantity. For example the weight of water produced is exactly equal with the weight of oxygen and hydrogen used for the purpose. Likewise the weight of the iron used is found to be exactly identical with the weight of the utensil which is manufactured out of it. So in both the cases there is quantitative equality of matter between the cause and the effect it has produced. It is to be borne in mind that in the process of transformation of the cause into the effect no quantity is lost. It remains unchanged, the form of course changes. Oxygen and hydrogen are gaseous in nature but the effect they produce, i.e. water, is liquid.

The law of conservation of energy likewise states that the total quantity of energy in the world remains the same always. It neither increases nor decreases. What changes is the form of the energy only but not its quantity. One form of energy may change into another form without affecting its original quantity. In other words there is quantitative equality in regard to energy between cause and effect. Thus, for example, when a moving vehicle stops, we say that the motion in it is lost. But actually it is never so. No energy is actually lost. Here motion is not lost.

On the other hand the form of motion is converted to heat without affecting the original quantity. Likewise we all are in possession of potential energy. But when we start doing our work the potential energy is converted into kinetic energy. It is also a fact that the kinetic energy thus spent is exactly equal in amount to the original potential energy we had, before we started the work. So the form of energy only changes from potential to kinetic but in the process of transformation of cause to effect the quantitative equivalence of the energy remains unchanged or unaffected.

Read has defined cause as quantitatively equal to the effect. The effect, actually speaking, is nothing but the cause transformed. The matter or the energy which disappears as cause reappears as effect and in the process of appearance and disappearance the quantitative equivalence of both matter and energy and for that matter cause and effect remains the same. It neither increases nor decreases. That is why cause is said to be quantitatively equal to the effect.

Thus, the cause of an event is qualitatively the invariable, unconditional and immediate antecedent and quantitatively equal to the effect.

8.4 POPULAR VIEW OF CAUSATION :

A common man is not reflective to inquire the cause of a phenomenon. Common people are superstitious in their beliefs. When they seek to know the cause of a phenomenon they do not take a scientific view of causation. A scientific view of causation is most dependable whereas popular view of causation is unreliable and even vague at times. In explaining natural phenomena sometimes common people attribute some supernatural cause. But science does not accept any supernatural agency or explanation. There is nothing called supernatural in scientific framework. For anything that occurs in nature is a natural phenomenon and every natural phenomenon can have only some natural cause whether we know it or not. To discover or explain the cause of a phenomenon in a scientific way is to add to human knowledge or information. Thus to explain phenomena in a scientific way is the need of man's intellectual quest. So it is better to guard against the popular view of causation. Now let us explain some popular views of causation and see how these explanations are incomplete and partial.

We have already discussed in this chapter that the idea of cause is extremely complex. It is not that easy to locate the cause of a phenomenon; for what we call a cause involves many factors or conditions. We have also discussed how cause is the sum total of conditions. There are positive as well as negative conditions. For various reasons sometimes only one condition or at times even a negative condition is chosen from the set of conditions and is given the status of a cause. That is popularly done in absence of a reflective mind.

Often the last condition which appeared just before the occurrence of the effect is considered to be the cause. In a football match who at last scored the lone goal for the victory of the team, is considered to be the cause of the victory. Left to himself he could not have scored the goal. It is because the entire team of players joined together he could score the goal. Thus he is just a condition like all other players.

Similarly sometime a negative condition is selected and elevated to the rank of a cause. For example, the cause of death of a snake-bitten patient is attributed to the absence of a doctor. Again often the condition which looks very conspicuous is treated to be the whole cause. Thus for example, suppose a man slips his foot while climbing a ladder and is ultimately killed, The slipping is said to be the sole cause for his death. But actually slipping of the foot is just one of the several conditions which jointly led to the death of the man. Sometimes an unnecessary or wholly unconnected factor is chosen as the cause. Thus for instance, the failure of a student in the examination is attributed to calling him from behind when he was setting out of his house for the examination. Likewise hooting of an owl is considered to be the cause of death of the head of the family. These antecedents have nothing to do with the effects. We have already discussed that taking any antecedent to be the cause ends in the fallacy of *post hoc ergo propter hoc.* Sometimes a supernatural agency is brought in to explain the cause of a phenomenon. Many gullible people believe that godmen can bring out things from thin air. Astrologers ascribe the position of stars and planets to be the cause of the important events of a person's life. But these are all popular ways of thinking of a cause of a phenomenon in absence of reflective mind. The popular way of treatment of cause is thus wholly unsatisfactory. It is not only incomplete but unsound as well.

AGENT AND PATIENT :

In the context of cause sometimes a distinction is made between the agent and the patient. Agent is that which acts and the patient is that which is acted upon. Anything that acts is the agent and the thing that is acted upon is the patient. Injection given to a person is the agent and the human organism upon which it acts or has its action is said to be the patient.

But such a distinction is scientifically unsound because it is based on the supposition that the agent being the source of energy is active and the patient is passive or devoid of any energy. But things that are apparently passive are really the store house of potential energy. This potential energy is as much responsible for the production of the effect as the agent which manifests kinetic energy. In other words in the above example both the injection and human organism are equally responsible for any effect to occur. The agent and the patient are important conditions and they together constitute the cause for any effect to take place. The patient is not passive but also has an essential role in the concept of the cause. So the distinction is scientifically unsound. Mill, therefore, rightly observes, "the distinction between agent and patient is merely verbal, patients are always agents"

MOVING POWER AND COLLOCATION :

Moving power is the force which impels or incites the action. Collocation is arrangement of circumstances for the production of the effect. For example when a battery is affixed to the machine of a watch all the parts start functioning. Here the battery is called the moving power as it forces the parts to perform their respective functions, while the machine where parts are systematically arranged is the collocation. The effect i.e. the functioning of the watch as a whole is jointly produced by the moving power and the collocation. But neither the moving power(battery) nor the collocation(the machine of the watch) can produce the effect single handedly. Both are necessary for the required purpose i.e. showing time.

But popularly speaking moving power alone is considered to be the cause. But this is unscientific. For scientifically speaking both moving power and collocation are necessary factors of the cause.

8.5 PLURALITY OF CAUSES :

Plurality of causes is not based on scientific view of causation, rather it is based on the popular view. Plurality of causes is a common sense opinion for it means that a given effect or phenomenon may have been the result of alternative causes. In other words it states that one and the same effect can be produced by different causes on different occasions. According to Mill the same cause will always produce the same effect but not vice versa. In other words the same effect does not always follow from the same cause. It may be caused by alternative causes. Carveth Read maintains " the same event may be due at different times to different antecedents". Thus for example, light may be due to the sun, the moon, electricity or any other form of light. Death is caused by road accident, disease, suicide, starvation, or any of the hundreds of other circumstances that are capable of causing it. A crop failure may be attributed to any of the causes like flood, excessive rainfall, drought, attack of insects etc.

This view that there can be alternative causes of an effect conflicts with the idea that the cause is an invariable antecedent. If the cause is interpreted in the sense of being the invariable and unconditional antecedent or as the necessary and sufficient condition of the effect, then how to account for the doctrine of plurality of causes? If the scientific view of cause holds that every effect has a unique cause, then how does plurality of causes appear to be a doctrine? Of course the cause is not simple, but something extremely complex consisting of many conditions. But in spite of that there is only one such complex cause uniquely associated with an effect in question. This runs quite contrary to the doctrine of plurality of causes. In the light of the scientific view of causation the doctrine of plurality of causes has been criticised by logicians.

i) As the cause is taken specifically the falsity of the doctrine of plurality of causes can be noticed if the effect too is taken specifically. This way of finding fault with the doctrine of plurality of causes is called "specializing the effect".

It is a fact that the effect death is caused by disease in one case, by accident in another case and by starvation in yet another case and so on. But it is equally also true that death caused by accident is different from death caused by disease, and death caused by disease is also

different from death caused by starvation. Death due to accident does not produce the same features as death due to starvation. So death in all cases is not identical, it rather differs from case to case. In other words a specific type of death is produced in each case. There are alternative causes of death because there are different kinds of effect of death. If like the cause the effect too would be taken in its entirety there would not have been plurality of causes. On the other hand corresponding to a specific cause there would be a specific effect. In the given example the type of death due to accident can be produced by accident alone and never by disease or starvation.

ii) The falsity of the doctrine of plurality of causes can also be detected if like the effect the cause is taken generically. This way of proving its falsity is known as generalizing the cause.

While viewing the effect generically we should have also taken a general account of the cause. In brief if the effect was generalised the cause ought to have been genralised also. In that case many causes would not have been responsible for one and the same effect. In stead one definite cause will give rise to one specific effect. Thus for example when we generalise the different causes of death it will be noticed that the common or general character namely "failure of the vital functions" of human organism is the lone cause for the effect death.

The doctrine of plurality of causes arises due to divergent treatment meted out to cause and effect. So the defect can be rectified, as above, either by generalizing or by specializing both the cause and the effect.

Thus the doctrine of plurality of causes is thoroughly unsound from the scientific point of view. But the doctrine is a common sense opinion widely believed by an unreflective mind. However the doctrine of plurality of causes cannot be rejected on a priori basis. Rather the doctrine that every cause is the invariable antecedent is the result of empirical findings. That every effect is associated with a unique cause is known empirically, so the apparent plurality disappears when the effect is precisely and specifically mentioned. That establises the hypothesis that every phenomenon or effect has a unique and invariable single cause but not plurality of causes.

8.6 CONJUNCTION OF CAUSES AND INTERMIXTURE OF EFFECTS :

It is a matter of common experience that corresponding to several causes there are separate effects. In other words each cause acts separately to produce its specific effect. Not only the causes are separate their respective effects too are separate . For example, malaria has its own cause, typhoid has its own separate cause, influenza too has its own specific cause. Just as causes are separate and distinct, their corresponding effects too are separate and distinct. But nature being highly complex, rarely we come across simple phenomena. On the other hand often things are jumbled up and nature presents herself in a highly complex manner. Often several causes get mixed up and produce a joint effect. In such cases it is a difficult task to separate the causes and observe their effects separately. Now when separate causes act together and produce a joint effect the acting together of several causes is called "conjunction of causes" and their joint effect is called "intermixture of effects."

But conjunction of causes should not be mistaken for plurality of causes. For while in conjunction of causes several causes combine or act together to produce a single effect, in plurality of causes several causes act separately or independently to produce a single effect. To speak it out symbolically, in plurality of causes c_1 or c_2 or c_3 produces the effect e while in conjunction of causes $c_1+c_2+c_3$ produce the effect e.

There are two kinds of intermixture of effects, namely (I) homogeneous intermixture of effects and (ii) heterogeneous or heteropathic intermixture of effects.

In homogeneous intermixture of effects the joint effect is of the same kind or nature with separate effects. When switched on an electric bulb gives light. Again if one more bulb is lighted in the same room no doubt together they will provide more light. But nevertheless it is light only. So light is not only the joint effect of two bulbs operating together, it is also the effect of two separate bulbs operating individually.

In heteropathic or heterogeneous intermixture of effects the nature or characteristic of the joint effect is of different kind from the separate causes. Thus when oxygen and hydrogen are added in required proportion by means of an electric current then the resultant or the joint effect

is water. Here the nature of the joint effect that is water is different from the separate causes i.e. oxygen and hydrogen. In other words while water is liquid oxygen and hydrogen are gases. Likewise we take different types of food and the joint effect of all these is blood, bone, vitality etc. But blood and bone are of different in nature from the food we have taken i.e. rice, milk, vegetable, fish etc. In other words the characteristics of rice, milk etc are not found in blood, bone, vitality etc.

It is to be noted that in some cases the cause and effect are mutually convertible. But that is not a universal phenomenon. In the above example we get water from oxygen and hydrogen, so also we get oxygen and hydrogen from water experimentally. Such mutual convertibility of cause and effect is called transformation. But in other cases such convertibility of cause and effect is ruled out for neither can food be converted to blood and bone nor vice versa. The idea of intermixture and of convertibility is mostly illustrated in some area of science like chemistry, physiology etc.

8.7 PERMANENT CAUSE :

A cause may be temporary or permanent. A cause is temporary if it disappears after producing its effect. But a permanent cause continuously goes on producing some effect. The gravitational power of the earth, the heat of the sun, the pressure of the atmosphere etc. are instances of permanent cause. They are permanent for they never cease to operate. The accumulated influence of a permanent cause is called progressive effect. It is a complex effect which is the result of the permanent cause. Further permanent causes operate in two different ways. For example in case of gravity the force remains unchanged while acting upon a body. But in other case in stead of remaining fixed or constant it undergoes a continuous or progressive change as in case of decrease of atmospheric temperature as winter advances.

8.8 FUNCTIONAL DEPENDENCE :

The relation of functional dependence has been introduced by the modern scientists for calculating the exact relation between two phenomena. Particularly in well developed empirical sciences laws are formulated which give exact result in context of the quantitative characteristic of the cause. The notion of function is familiar in mathematics. For example if we say $y = x+1$, y happens to be a function of x for the value of y is definitely determined when x takes a determinate value. So in science attempts are made to formulate laws for exactly determining the functional relation of the characteristcs covering a cause and its exact effect. Einstein's formula $E = mc^2$ categorically states the mass-energy relationship. On the otherhand the proposition "water boils when heated" is not an exact contention to explain the relation of water and heat. But if it is held that water boils at 100^0 C it is expressed in more exact terms. That means some of the empirical laws are calculated in mathmatical terms because of their preciseness and exactness. That is what is called the relation of functional dependence.

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SUMMARY

LAW OF CAUSATION :

Every event has a cause, that is every phenomenon which has a beginning has a cause. The important characteristics of a cause are :

(i) cause and effect are relative concepts;

(ii) causal relation holds between a pair of events;

(iii) cause can be taken as the necessary and sufficient condition for the occurrence of the effect;

(iv) causal relation is an empirical relation, but not a logical implication;

(v) causal connection is not a relation between two isolated events, but there is generality in such a connection.

Aristotle considered cause as a compound concept and distinguished four kinds of causes. They are material cause, formal cause, efficient cause and final cause.

CAUSE AND CONDITION :

Cause is considered as the sum total of conditions, positive and negative. For the occurrence of the effect positive conditions must be present and negative condition must be absent. A negative condition is the preventing circumstance.

A necessary condition is the circumstance in the absence of which the event cannot occur. **A sufficient condition** is the circumstance in the presence of which the event must occur.

In a causal sequence there are several events connected like a chain. The immediate preceding condition of an event is called its proximate cause and the remote conditions in the sequence are called the remote cause.

QUALITATIVE AND QUANTITATIVE MARK OF CAUSATION :

Qualitatively cause is the invariable, unconditional and immediate antecedent of the effect and quantitatively equal to the effect. This is called the scientific view of causation which is distinguished from the popular view.

Plurality of causes is a common sense opinion according to which there can be alternative causes of an effect. Plurality of causes arises due to generalising the effect and specializing the cause. The problem can be remedied by following one standard for the cause and the effect. That means if the effect is to be generalised, the cause too should be generalised or if the cause is specialised the effect so too should be specialised.

Moving power and collocation and **agent and patient** also come under popular view of causation.

When separate causes act together and produce a joint effect, the acting together of several causes is called **conjunction of causes and intermixture of effects.** It may be of two types such as **homogeneous intermixture** and **heteropathic intermixture** of effects.

The idea of a **permanent cause** is that which never ceases to operate. **A temporary cause** is that which disappears after producing its effect.

In developed Sciences laws are formulated to calculate the exact relation between phenomena supposed to be causally related. That is called **functional dependence.**

MODEL QUESTIONS

GROUP - A

Objective Questions :

1. Answer the following :-

i) What is the quantitative mark of a cause ?

ii) What is the positive condition of a cause ?

iii) What does negative condition of a cause mean ?

iv) Give an example of plurality of causes

v) Define Cause

vi) Give an example of homogenous intermixture of effects

vii) What is an agent ?

viii) What is uniformity of co-existence ?

ix) What is uniformity of succession ?

x) What is the meaning of proximate cause ?

xi) Is causal relation a logical implication ?

xii) Name the different kinds of conjunction of causes and intermixture of effects.

2. Fill in the blanks :-

i) Cause is the sum total of _____ .

ii) In causation the thing acted upon is called _____.

iii) When the same effect is produced by different causes it is called _____.

iv) Quantitatively cause is equal to _____.

v) Qualitatively cause is the _____, unconditional and immediate antecedent .

vi) In ___ intermixture of effects the separate effects and the joint effect are of different types.

vii) In homogeneous intermixture of effects the separate effects and the joint effect are the _____.

viii) Cause and effect are _____ terms.

ix) The cause is always an _____ of the effect.

x) Cause is both the necessary and _____ condition for the occurrence of the effect.

GROUP - B

Short-type Questions :

1. Distinguish between the following :-

i) Cause and condition

ii) Positive condition and negative condition

iii) Remote cause and proximate cause

iv) Necessary condition and sufficient condition

2. Answer the following-

i) What is the fallacy of taking a coeffect as the cause ?

ii) What is the quantitative mark of causation ?

iii) Explain the fallacy of post hoc ergo propter hoc.

iv) What is the meaning of homogeneous intermixture of effects ?

v) Explain with an example the idea of heteropathic intermixture of effects.

vi) Explain the idea of a permanent cause.

vii) What is plurality of causes?

viii) How has Carveth Read defined scientific cause ?

ix) What is the significance of generalising the cause and specialising the effect ?

x) What is the meaning of invariable antecedent of an effect ?

GROUP - C

Long-type Questions :

1. Explain the different qualitative marks of causation.

2. Discuss the scientific view of causation.

3. What is plurality of causes? Is it scientifically tenable?

4. Distinguish between plurality of causes and conjunction of causes.

5. State and explain the meaning of conjunction of causes and intermixture of effects. Illustrate its different kinds with examples.

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CHAPTER-9

MATERIAL GROUNDS OF INDUCTION

Introduction :-

Induction is usually defined as the establishment of the material truth of a general real proposition. Hence purely formal grounds cannot be enough for the establishment of the inductive conclusions. The material truth is assured by material grounds. For the material truth the particular instances are taken into consideration through observations or experiments. Thus observation and experiment are the material grounds of induction. In order to arrive at a conclusion like "All crows are black", it is very much required to observe the colour of some particular instances of crows. Similarly, in order to arrive at a generalised conclusion like "Water is composed of hydrogen and oxygen", one has to check its composition through the experiment of the electro-chemical analysis of water. It has been said that each premise of the inductive reasoning stands for one particular instance, that is expressed by the help of one true proposition. Those true propositions become the basis for the conclusion. Those true propositions are usually obtained through observation or experiment . In this way observation and experiment supply the materials of inductive reasoning.

9.1 OBSERVATION :

Every moment we are exposed to some kind of events or occurrences. If we try to frame some definite opinion about the events we come across, we have to observe the instances keenly. The random observation of instances won't help for any clear understanding of the phenomena of nature. In the words of Jevon, "To observe is merely to notice events and changes which are produced in the ordinary course of nature, without being able, or at least attempting to control or vary those changes". In this way, observations performed with a definite purpose are different

from the casual perceptions.

'Observation' has been derived from the Greek words 'ob' and 'servare'. The above two words stand for the meanings 'to keep' and 'before the mind' respectively. The knowledge derived by placing something before the mind leads to observational knowledge. Usually the perceptual knowledge is considered as the observational knowledge. But in respect of the inductive reasoning 'observation' has been defined as regulated perception with a definite purpose. It shows that three factors are involved in the case of an observation. There must be some object to be observed, the sense organs to observe the object and the mind to become aware of it. This process is repeated for several times in order to arrive at a conclusion.

DEFINITION : Observation is regulated perception of facts or events, under natural conditions, to arrive at explanation concurring the observed facts or events.

CHARACTERISTICS :

i. Observation is the case of regulated perception of events. Observations are made by help of sense organs. So it is basically perceptual. Perception may be either external or internal. Perception of natural events or occurrences is external perception. To know something directly by introspection without using the sense organs is called internal perception. Feeling of sorrow, joy, happiness etc. is internal perception.

A vast nature is present before us. Every moment we come across some event of nature. When similar type of events are observed in repeated manner, one feels to find out an explanation with regard to the functioning of nature. That helps us to distinguish the random or casual perception from regulated perception.

ii. Observation should be systematic and selective. Observation excludes the cases of careless and stray perceptions. It should be systematic and selective. When the purpose of observation is decided we select those instances, which have got relevance with the purpose. Suppose we want to observe the colour of the crows. Then out of the different types of birds we select only crows to observe. Hence perception should not be careless or a casual one. The aim of perceptions is to establish some generalised truths. A general

truth cannot be derived from stray or casual perception. The perception should be systematic and selective.

iii. Observation should be impartial and free from any bias.It means that the observation should be strictly objective. Sometimes in order to establish a definite conclusion we overlook certain instances, which are not favourable to the conclusion. For example, when a sales representative demonstrates the utilities of a particular product he only shows us some of the suitable utilities of it. He overlooks those instances, which are not favourable for the purpose of demonstration. This is an example of biased observation. Such types of biased observation should be avoided. Observations should be objective. Similarly, observation should be neutral. If the neutrality is not maintained it may lead to fallacious observations. For example, while evaluating the answer scripts if the examiner thinks that he is evaluating the scripts of brilliant students then the mistakes present in the answer script may be overlooked.

A prejudiced mind cannot make observation neutral. If a person is biased, then his observation will not be true or objective.

iv. Joyce has pointed out that very often observations are not free from subjective influences. There can be three types of subjective influences of the observer, namely, intellectual, physical and moral.

a) The intellectual condition refers to the interest and sincerity of the observer for knowing. If there is no desire to know something then careful and objective observation may not take place. Because of this condition we make a distinction between intentional observation and baseless observations. A sound mind of the observer helps in satisfying this condition.

b) The sense organs of the observer should not be defective. In such cases the observations will lead to fallacious observations. Moreover, our sense organs have limited ability of perceiving the things. The germs are not visible to naked eyes. Many

stars and planets are not visible to us. A colour blind man cannot observe colours perfectly. In such cases if the proper instruments are not used erroneous observations take place. Hence the physical condition should be satisfied for true and unbiased observations.

c) The third condition is moral one. It is obvious that for impartial observation there should not be any dogma or bias. Thus for impartial observation the observer should be free from impositions or any influences. Unless one is having a free and impartial mind his observation may not be objective, real and accurate.

v. Observation is the active process of knowing the truth. Knowledge through observation is always active. The involvement of sense organs makes it active. Of course, the experiments are more active as compared to observations. But observations are not passive.

vi. Observations should be simple.Simple and direct observations help in knowing the uncontroversial truths. Since the aim of observation is to obtain right knowledge and to establish the material truth of a general proposition it should be simple and direct.

GENERAL CONDITIONS OF OBSERVATION :

In order to have successful observation some conditions need to be fulfilled, failing which it may lead to fallacious observations. The conditions may be either objective or subjective. It is very much clear that we use our sense organs for observations. But our sense organs have some limitations. By the help of eyes we can see many things. But there are also very minute objects, which are not visible to us through our normal vision. For example the bacterias, germs, etc. are not visible to our naked eyes. Here the objective conditions are not satisfied for the successful vision of minute particles. Similarly, we hear sound when it is up to a particular limit. If the sound is beyond that limit or lower to the audible range, then we cannot hear it through our ears. For that some instruments may help in satisfying the objective conditions of the observation. The presence of sufficient light for the observation of perceptual objects is an objective condition.

It is quite obvious that for successful observations the objective conditions need to be satisfied. But some logicians points out that satisfying this condition is not enough. Joyce points out that there is also the need of satisfying the subjective conditions to have a successful observation. And he points out three such conditions, namely, intellectual, physical and moral.

INTELLECTUAL CONDITIONS :

This condition refers to the intensity of the desire of the observer in order to have the observation. Unless the observer is serious about the purpose of observation, the observation may not be up to the mark. Thus the observer must have the desire to know about something for which he has to undertake some observations. This desire to know is considered as the intellectual condition of observation.

PHYSICAL CONDITION :

This condition refers to the sound reception capacity of the observer. The observer gets the observational knowledge through his sense organs and mind. Unless the sense organs are non-defective and the mind is sound one cannot expect correct observational knowledge. Say, for example, an insane person's observation is not taken as a standard observation. The visual report of a person who has poor eyesight cannot be taken to be acceptable. Thus in order to have clear observation the observer should have a sound mind and sound sense organs, i.e. he must be physically sound.

MORAL CONDITION :

It refers to the impartiality of the observer. Jevon says, "It is not easy to find persons who can with perfect fairness register facts both for and against their own peculiar views". That means very often people are influenced by their own judgments about the facts of observation and lose impartiality of observations. For example, while going to evaluate the answer scripts if it is kept in the mind of the examiner that he is evaluating answer scripts of his own students then impartial observation may not be possible. The imposition of own ideas upon the observed facts leads to faulty observations. That will lack impartiality Hence observer should be free from all kinds of

bias, prejudice and personal considerations prior to going for observations.

Besides all these subjective conditions, it is also quite important that there should be favourable natural condition for the observation.

FALLACIES OF OBSERVATION :

The possibility of error in the process of observation cannot be ruled out. Erroneous observation leads to fallacious induction. Fallacies in observation vitiates the purpose of inductive procedure. It is necessary to know the fallacies of observation so as to remain careful not to commit them.

The fallacies of observation are mainly of two types, namely negative and positive. The negative fallacy is the result of non-observation and the positive fallacy is the result of mal-observation.

NON-OBSERVATION :

The fallacy of non-observation occurs when what should have been observed is over-looked. They are also of two types, non-observation of essential circumstances (partial non-observation) and non-observation of instances (complete non-observation). They are very common in our day today life. Let us illustrate them:-

a) Non- observation of essential instances:- The instance which is important for the purpose of investigation if overlooked, while making the observation, then it leads to the fallacy of non-observation of essential instances.

For example, suppose a person actually suffers from malarial fever. While examining if the doctor overlooks malarial symptoms and takes it as some other fever, it becomes a case of non-observation of essential instances. This fallacy can be avoided if extreme care is taken at the time of investigation.

There are also cases where the part of the object is visible but not the whole. The invisible part might include some essential evidences. When we observe the moon, it is visible

partly. It is a case of partial non-observation. One can use instruments and repeat the observation for a number of times to improve the knowledge of partial observations.

B. **NON-OBSERVATION OF INSTANCES :**

Non-observation of instances is a fallacy in which we overlook instances, which are relevant for investigation. It is a case where some instances are overlooked either unknowingly or because of certain prejudices. Suppose we are in habit of offering a prayer before we go for appearing examinations. We get a good result. Here a superstition is built up that to get a good result prayer is necessary. We only cite such examples where we offer prayer and have got good results. And we fail to observe a number of instances where good result is there without having prior prayer. Thus many superstitions are framed due to the non-observation of instances.

Just like partial non-observations, there may be also cases of complete non-observations. The germs are not visible to the naked eye. We see a glass of water and decide that it is pure and worth drinking. It is because of the fact that the presence of the germs is not observed at all. It is a case of complete non-observation.

MAL OBSERVATION :

There are cases of observation where the actual object is observed as something else. These are the cases of positively wrong observations. For example, sometimes a mirage is perceived as water or a straight rod is perceived as bent one when half immersed in water. Similarly the parallel train lines appear to be meeting at a point is also a case of fallacious observation. Such types of positively wrong observation are known as mal observation. Mal observations are categorised into two types, namely, individual mal-observation and universal mal-observation.

a) Individual mal-observation :-

When an individual wrongly observes a thing to be another it is individual mal observation. The observation of a rope as a snake is an example of individual mal-observation. It is a case where an individual is confused with unconscious inference that leads to the fallacy. Unconsciously one reaches at the conclusion that what he observes is a snake, whereas it is actually a rope. If he would have been careful enough then he would have observed it as a rope.

b) Universal mal-observation :-

There are certain cases of illusions and hallucinations which are universally found with every one. Every one is liable to commit that mistake under similar circumstances. Whoever stands at one end of a train line the parallel lines appear to be merged at certain point. Here careful observation will not help in overcoming such wrong perception. Because it is possible for every one to commit this fallacy it is called universal mal-observation. Incase of universal mal-observations undue assumptions are wrongly inferred. The most popular example of universal mal-observation is the case of sunrise and sunset. We think that we observe sunrise and sunset, whereas scientifically considering there is neither sunrise nor sunset.

9.2 EXPERIMENTS :

Experiment is another material ground of induction. In case of experiment some phenomena of nature are studied under pre-arranged conditions. Experiment can be explained as artificial reproduction of events under controlled conditions. Bacon considers that in experiment we interrogate nature. In experiment there is a definite purpose i.e. to arrive at a conclusion on the basis of the findings under conditions selected and prearranged by the experimenter. Experiments are widely used by the scientists and considered to be the part and parcel of the subject matter of sciences. Experiments become the basis of establising scientific truths. Experiments are mostly conducted in the laboratories by scientific instruments. Bain considers that experiment is a method of 'making of fact' in the sense of establishing the generalised truth about the fact. A fact is directly experienced in case of an experiment.

It is quite important to note that even through experiment is considered as a separate material ground of induction (as compared to observation) no experiment can be conducted without observations. That is experiments are also observed and the former cannot do away with the latter. But while experiment requires active involvement of the experimenter to reproduce some event observation studies phenomena only when they occur in nature. In this sense some logicians consider that observation is passive whereas experiment is active.

We find water as a part of the natural phenomena. Scientists have experimented with water and have found it to be the combination of hydrogen and oxygen at a particular ratio. This view or the conclusion of the scientists has been accepted as a general truth on the ground of experiments. Any one can verify this truth under the agreement of certain conditions. The verification can be done for any number of times also. Thus the experiments help us in arriving at an acceptable truth and the experiments are always within our control.

NATURAL EXPERIMENTS :

Sometimes nature creates a special circumstance for our observation of some event, It is called natural experiment. Where nature makes the arrangements for the production of a definite effect, Jevon calls it natural experiment. For example, before the invention of rockets or the satelites it was not possible to know the shape of the earth. But special circumstances of nature like eclipses, have helped to know the shape of the earth through its shadow. This knowledge regarding the shape of the earth could be possible through special circumstances of nature i.e. eclipses. Such type of cases is considered to be natural experiments by Jevon.

Strictly considering such types of cases need not be named as experiments. Because adequate justification cannot be given to consider those to be experiments. Experiments are arranged ones. Nature cannot be treated as an arranger. So it is not proper to consider them as experiments.

9.3 RELATION BETWEEN OBSERVATION AND EXPERIMENT :

There are certain points of similarities and dissimilarities between observation and experiment.

SIMILARITIES :

a) Both of them are material grounds of inductive inference.

b) Both of them aim at explaining certain facts and provide us knowledge about the facts.

c) There is the involvement of physical, moral and intellectual conditions in both the cases of observation and experiment. For impartiality one should be physically, intellectually sound and morally unbiased.

d) Both are the case of observations. The experiments are also observed.

DISSIMILARITIES :

a) Observation is defined as the regulated perception of events or phenomena of nature. Experiment is defined as the artificial reproduction of events under the arranged conditions.

Thus, the former is the perception of natural events and the later is the perception of artifically reproduced events.

Bain explains it as: observation is finding a fact, experiment is making one.

b) For observation one has to depend upon nature. The events of nature are not in our control. The observer is a passive onlooker.

But in case of experiment we interrogate nature This view is maintained by Bacon. In case of experiment we are actively involved to reach at a definite answer in respect of certain querries about the nature.

c) The knowledge obtained through observation is comparatively less certain than the knowledge obtained through experiment.

d) Modification is not possible in case of observation. A modified observation is treated as a fresh observation or another piece of observation.

But modifications are allowed in case of experiment in order to become sure about the findings of observation.

ESTIMATE :

The considerations that observation is strictly passive and experiment is strictly active, or that observation is strictly natural and experiment is strictly artificial, are definitely misleading. Observation cannot be strictly passive nor can it be completely natural. In observation the event is presented by nature under natural circumstances. So it is more natural a process than

experiment. Similarly experiment is not strictly artifical. In experiment the phenomenon is artificially produced under controlled conditions which the experimenter can vary. Here the experiementer only sets the facts to see how they behave. Hence there is difference in degrees in respect of these above two considerations. Thus they are not completely opposed to each other, rather both may be considered as complementary. Both aim at explaining the facts, so are not opposite processes. They do not differ in kind but only in degree.

9.4 RELATIVE ADVANTAGES OF OBSERVATION OVER EXPERIMENT :

1. Observation has wider scope of use as compared to experiment.

There are certain cases where observation is the only mode of acquiring knowledge. It is not possible to artificially reproduce the stars, the heavenly bodies in the laboratory and make experiments on them. The knowledge about such distant objects like stars, comets, etc. or the effect of some unusual circumstances like earth quake, war etc. is known through observations only. In this sense the observation has wider scope of application and it is universally applicable.

2. One can pass from cause to effect and effect to cause in observation :

It is the most important limitation of experiment that the sequence of the events cannot be done in the reverse order. The causal event has to be applied first then the effect is to be observed. 'Heat expands material bodies' can only be verified through the experiments where heat is to be applied first. So in case of experiments we only pass from cause to effect, but in observation either way is possible.

3. Observation is the precondition to experiment :

It means that observation is a preparatory way for experiment. Whatever may be the experiment it is to be observed first. Newton observed the fall of the apple first and then proved the gravitational force through experiments. It shows that observation precedes experiment but experiment does not precede observation.

9.5 RELATIVE ADVANTAGES OF EXPERIMENT OVER OBSERVATION :

1. The experiments are performed under the control of the performer. Hence the problem of waiting for the occurrence of the event in nature does not arise is case of experiments. If some one wants to study monsoon, then he has to wait till the time of monsoon to come. The object of observation is very often in the control of the nature.But in case of experiment, the object of observation is under the control of observer. The observer can arrange the situation to study the phenomenon under controlled condition. Here he is not under the mercy of nature. So the advantage of the experiment is that here waiting for the nature is not required.

2. The change, modiification and repeatition are possible in case of experiments as per the requirement. The performer of the experiment is the master of the situation. The experiment is always within his control. He can repeat or modify it as per his need. But such type of addition or alteration of conditions is not possible in case of observations. In experiment one can isolate or vary a phenomenon in a complex situation for his study. From experience it is known that combustion of something is possible when it is in open air, without air it does not burn. But air is the mixture of different gases. Which gas helps for combustion cannot be known by observation. But by experiment one can separately apply nitrogen, carbon, oxygen etc. to confirm which gas helps for combustion. By experiment it is found that oxygen is the gas that helps fire to burn.

3. Quantitative changes can be brought in case of experiments. This can be explained by the help of an example. A doctor experiments with a patient by applying certain medicine with certain doses. He may experiment with it by increasing or decreasing the dose to study the result. Thus experiments can be undertaken by increasing or decreasing the quantity of the ingredients because quantitative changes are possible in case of experiments. But such quantitative changes cannot be brought in case of observation.

4. One important advantage of experiment is that it helps to study the situation with coolness

of mind and patience. In observation we are in a hurry to study something when it occurs lest it may disappear. When we observe a comet or an earthquake we must be alert at that moment since it will last for a short duration. But this problem is not there in experiment as it is in our control. We can prolong an experiment as long as we want it but this opportunity is not there in case of observation.

5. Exactness of a study can be ascertained only in experiment but that is not possible in case of observation. Since there is scope for repetition and varying of the situation, accuracy of a result is possible in experiment. An agricultural scientist studies the impact of a chemical fertiliser on some seed in different varying circumstances. A pathologist studies the effectiveness of different anti-biotics by making culture of urine or blood. The accuracy of a study can be achieved by experiment but not by observation.

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SUMMARY

MATERIAL GROUNDS OF INDUCTION :

Observation and experiment are considered as the two material grounds of induction. Observation is the regulated perception of phenomena under natural conditions. In order to have satisfactory observational knowledge the physical, intellectual and moral conditions are to be observed carefully. Further it is also necessary to remain careful not to commit the fallacy of observations. The fallacy may occur when something is wrongly observed as something else, or due to non-observation of instances or essesntial circumstances. The former fallacy is called mal-observation and the latter fallacy is called non-observation.

Experiment is the artificial reproduction of event under pre-arranged conditions. In experiment the instances can be repeated. Here we can have the advantage of applying quantitative changes.

Observation and experiment do not differ in kind but only in degree. Each of them has some relative advantage over the other.

MODEL QUESTIONS

OBSERVATION AND EXPERIMENT

GROUP – A

Objective Questions :

1. Answer the following :-

a. What are the material grounds of induction?

b. Give an example of experimental observation.

c. What is simple observation?

d. Is observation possible without experiment?

e. Give an example of mal-observation.

f. What is experiment?

g. State one of the advantages of observation over experiment.

h. State one of the advantages of experiment over observation.

i. Name two different fallacies of observation.

j. What is natural experiment?

2. Fill in the blanks :-

a. Experiment is a _____ ground of induction.

b. Observation is _____ perception.

c. In _____ we can multiply the instances.

d. Observation and experiment do not differ in _____.

e. When something is wrongly observed it leads to the fallacy of _____.

f. Mal-observation is a _____ fallacy.

g. Between observation and experiment isolating a phenomenon in a complex situation is possible in _____.

h. When some essential circumstances or instances are overlooked it leads to the fallacy of _____.

i. Non-observation is a _____ fallacy.

GROUP – B

Short type Questions :

1. Explain the following:-

a. What is natural experiment ?

b. What is non-observation of instances ?

c. What is non-observation of essential circumstances ?

d. What are the conditions of observation ?

e. Why in experiment the experimenter is not in a hurry ?

f. Why is experiment not possible without observation ?

g. Why has observation a wider scope than experiment ?

GROUP – C

Long-type Questions :

1. What is observation? Explain its nature and characteristics.

2. What is experiment? Distinguish it from observation.

3. Observation and experiment do not differ in kind but in degree---explain.

4. Discuss the relative advantages of observation over experiment.

5. Discuss the relative advantages of experiment over observation.

6. Why is observation the material ground of induction? Discuss its fallacies.

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CHAPTER - 10
HYPOTHESIS

Hypothesis is used as a step in the procedure of induction. Before the inductive generalisation, usually a hypothesis is framed. It is a stage of making a probable supposition. It is not the only use of hypothesis. Hypotheses are used very frequently by the natural scientists. It is also a probable supposition to explain certain facts or phenomena whose explanations are not known. To explain and organise certain facts and to bring them under certain law is the very objective of the inductive procedure for which hypothesis is framed. Hypothesis is thus, formulated to know the possible explanation, either causal or otherwise, of a phenomenon. When the cause or explanation of a phenomenon or a class of phenomena is not known or is not explainable with the existing knowledge, a hypothesis is formulated. It is the supposed or provisional explanation of the phenomenon.

10.1 DEFINITION OF HYPOTHESIS

Mill defines hypothesis as "any supposition which we make either without actual evidence or on evidence avowedly insufficient in order to endeavour to deduce from it conclusions in accordance with facts which are known to be real under the idea that if the conclusions to which the hypothesis leads, are known truths, the hypothesis itself either must be, or at least is likely to be true."

It is a definition of hypothesis that tells us what a hypothesis should be.

Coffey defines hypothesis to be "an attempt at explanation, a provisional supposition made in order to explain scientifically some fact or phenomenon".

Stebbing expresses it as 'a hypothesis is a proposition suggested by the evidence available to establish the conclusion but insufficient to demonstrate the conclusion'. Hypotheses are framed when we seek to ask why something has happened. A hypothesis is, thus, considered to be a supposition for the possible explanation of facts.

Let us take one example to explain it. Suppose one day at a particular time when we arrive at the station to board the train, we do not find the heavy crowd on the platform which normally should have been there during the time of the departure of the train. It puzzles us. We try to know the reason. Here a possible explanation comes to the mind that perhaps there is rail-strike somewhere for which the trains are cancelled. Or may be there is some derailment for which the schedule has been changed. Such explanations are different attempts to remove the puzzlement. After inquiry or verification we can be sure of the reason.

Modern logicians prefer the term ' explanation' in place of 'hypothesis'. Logicians, Copi and Cohen, have given the definition of an explanation in the following manner: "An explanation is a group of statements or a story from which the thing to be explained can logically be inferred and whose acceptance removes or diminishes its problematic or puzzling character".

The explanations may be concerning scientific truths or may be concerning the facts of every day life. Accordingly there are two types of explanations, namely, scientific and unscientific.

CHARACTERISTICS OF HYPOTHESIS

i) Hypothesis is an attempt at an explanation of certain puzzled facts. It is the attempt to find out the possibility of the occurrence of such a fact. Sometimes it is framed to explain certain scientific truth or to explain a law.

ii) It is a probable explanation or presupposition of a cause. If the cause of an event is not known, the investigation starts with a probable cause. For example, if we perceive the effect of an accident and the cause is not witnessed, then the possible reasons of the accident are thought of for investigations.

iii) No hypothesis is certain or definite at the stage of assumption. It is merely probable. It may be framed without evidence or evidence avowedly insufficient. So it requires verification for confirmation.

iv) Through hypothesis facts are organized in a systematic manner. The aim of hypothesis is to reach at the real explanation and to remove the puzzlement concerning the event. It is possible through systematization of involved facts. In this way very often hypothesis is framed to explain a law.

v) Formation of hypothesis is keenly connected with the verification of it. Hypothesis is found in the form of a conclusion. It is compared with the known facts to decide whether such a conclusion can be deduced. If so the relevance of the hypothesis is accepted. Logical form of a hypothesis :

E (effect) is due to either h_1 or h_2 or h_3 or h_4.

not h_1 (If h_1 then A, But not A, $\therefore$ not h_1)

not h_2 (If h_2 then B, But not B, $\therefore$ not h_2).

not h_3 (If h_3 then C, But not C, $\therefore$ not h_3).

Since E is not due to h_1, h_2 or h_3 E is due to h_4. This logical form is applicable if the number of causes of a hypothesis is fixed.

10.2 KINDS OF HYPOTHESIS

Different logicians have classified hypothesis in different ways. We shall discuss some important classifications here :-

1. READ'S CLASSIFICATIONS:

According to Carveth Read, hypotheses are of three types.

a) **Hypothesis Concerning Agent :**

When a hypothesis is framed with a supposition that a being or some agent is responsible for the occurrence of the event, it is considered as the hypothesis concerning agent. In case of a theft, the supposition is concerning persons committing the theft. Hence, those suppositions are hypothesis concerning agent.

b) **Hypothesis Concerning Collocation :**

When provisional suppositions are formulated in respect of explaining certain facts of nature referring to certain circumstances responsible for the occurrence of the facts, those are considered to be hypothesis concerning collocation. Geocentric hypothesis was framed by Ptolemy and heliocentric hypothesis was framed by Copernicus to explain the relation between the sun and the planets alongwith the causes of day and night. That is considered to be hypothesis concerning collocation.

c) **Hypothesis Concerning Law :**

In respect of certain facts, the agent is known or the circumstances involved are known, but the method or process involved in it is not known. If presuppositions are framed for this unknown process, then it becomes a hypothesis concerning law. Because the method does not refer to one particular instance, it is concerned with a type or category for which the verified hypothesis leads to a law.

The law of gravitation was established by a hypothesis of this sort.

2. WELTON'S CLASSIFICATION:

Welton and Coffey classify hypothesis into two types.

a) Hypothesis of Cause:

Welton does not differentiate between hypothesis concerning agent and collocation. He puts both the categories in one type and considers it as hypothesis concerning cause. Any hypothesis that explains the cause of a phenomenon is a hypothesis concerning cause. In case of events of nature, the agent and the circumstance fall in one group,

according to Welton. Hence, for Welton, such hypothesis should be considered as hypothesis of cause.

b) Hypothesis of Law :

According to Welton, the causal hypothesis is explanatory whereas a hypothesis concerning law is descriptive. A law describes phenomena of nature, hence it is descriptive. In this respect hypothesis of law is different from a hypothesis about a cause.

This classification of Welton has not been accepted as satisfactory.

3. Stebbing's Classification:

She Classifies hypothesis into three types. They are :

a) **Explanatory Hypothesis:**

It is a case where a hypothesis is framed to reconstruct the existing view (explantion) in respect of the occurance of some effects. It involves a positive explanation in support of the effect. The explanation may differ from the existing view or the common understandings. For example, an advocate may explain the cause of a crime in such a manner that B is now regarded as the culprit in place of the common understanding that A is the culprit. The reconstruction of the issue by the advocate can be considered as explanatory hypothesis.

b) **Descriptive Hypothesis:**

Very often certain probable description helps in simplifying certain complicated facts or effects. It provides a model that helps to comprehend a complicated situation. To explain some complicated phenomena, a model is thought of by a scientist. Though it is provisional in nature it helps to carry out further observation and experiment to reach a definite conclusion. For example, Ptolemy's trial to describe planetory motion by the help of geometrical figure really helped in the understanding of their motion. Though further investigation disconfirmed it, it was helpful at a time to understand the nature of planetory motion.

c) **Analogical Hypothesis:**

Analogical hypothesis is a development on descriptive hypothesis for the following reason. In certain cases two sets of phenomena resemble to a great extent. When a descriptive hypothesis is found to be applicable in one case, the same set of principle is applied to the other case also. It helps in framing the hypothesis basing on the resemblance of factors. It is called analogical hypothesis.

Scientists could notice a great deal of resemblance between the planets Earth and Mars in respect of temperature, atmosphere, etc. On that basis a hypothesis could be framed that since living beings are there in earth there may be living beings in mars. This category of hypothesis is considered to be analogical hypothesis. Stebbing defines it as : by an analogical hypothesis we mean a hypothesis that what is true of one set of phenomena may be true of another set owing to the fact that the two sets have in common certain formal properties.

Mexwell's hypothesis, which is based on the similarity of principle between gravitational attraction and electrostatics is considered as an example of analogical hypothesis.

4. Other types of hypothesis:

a. Working Hypolthes:

A working hypothesis is formulated in the absence of a good and reasonable hypothesis. In absence of a reasonable hypothesis to explain some event or situation, some hypothesis is formulated for guiding further investigation. One cannot remain silent on the ground that sufficiently reasonable hypothesis is not there. One should proceed with the investigation with some supposition. This one is known as a working hypothesis. It may give some further clue to carry out investigation. When a satisfactory hypothesis is discovered, the working hypothesis is rejected. For example, in case of a theft, an

investigator does not wait for a reasonable hypothesis. He starts investigation with some supposition. That may provide some clue to ascertain the cause. This is described as working hypothesis.

b) Adhoc-hypothesis:

If any difficulty is found in respect of an existing law or an accepted truth, the law is challenged immediately. First of all a hypothesis is framed to find out the cause of the difficulty. The hypothesis that is framed to solve the problem involved in case of a law, is known as adhoc-hypothesis. An adhoc hypothesis remains adhoc till it is either confirmed or rejected. For example, the path of Uranus was decided as per the law of gravitation. Later on some deviations were marked. In course of finding out the cause of deviation it was supposed that the deviation might be due to the presence of some other planet. In fact Bourvord discovered the planet Neptune through this method.

c) Non-instantial Hypothesis:

Non-instantial hypothesis is a case of theoretical assumption where direct verification is never possible. It is framed depending upon the knowledge gained in the field of science at a developed stage in order to establish an order among the theories. It systematises the generalisations by help of a higher theory. Observation of fact is not available here. This category of hypothesis is mostly used in case of secondary induction. For example, Maxwell reached at the electromagnetic theory of light through a non-instantial hypothesis. Einstien's theory of relativity is also an instance of non-instantial hypothesis.

10.3 CONDITIONS OF LEGITIMATE HYPOTHESIS:

A hypothesis is a probable supposition. But any wild guess should not be treated as hypothesis. A hypothesis should possess a higher degree of probability. Newton makes a remark on certain hypotheses by saying "**hypothesis non-fingo"**. It stands for the expression "I do not form hypothesis". It signifies that unless the degree of probability is high, there is no meaning to

take any stray supposition to be a hypothesis. It shows that if a hypothesis lacks the higher degree of probability, it is not considered as a legitimate hypothesis. For this reason logicians have suggested some broad conditions for considering a hypothesis to be legitimate.

i) A legitimate hypothesis cannot be framed with a self-contradictory statement or absurd expression. It should be definite and specific. All self-contradictory statements are meaningless statements. It is never possible that with the help of self-contradictory statement any fact can be justified. It is to say that the statement of hypothesis should be sensible, neither meaningless nor absurd. The hypothesis should be precise, definite and not vague.

ii) The hypothesis should be adequate. A hypothesis is required when there is demand of explanation in respect of some problematic event. If the hypothesis is not adequate it cannot explain the event correctly. In order to become adequate the hypothesis should be framed after taking all the connected known truths into account. For example, in case of a theft without considering any other fact if some one says that the servant is the thief then it is not adequate. In a complex situation the possible reasons thought of may be quite insufficient or quite irrelevant to explain the fact. If we say that a political leader is responsible for our social evils here it is not clear in what way he is responsible for the effect. If we say that the city plan is responsible for the social evils here it becomes an irrelevant conjecture. So the hypothesis should be adequate in the sense that there must be adequate basis of framing the hypothesis and the basis is the capability of explaining the facts(effects).

iii) The hypothesis should be verifiable. Since it is only a provisional supposition the verifiable aspect of the hypothesis is very important. No hypothesis can be accepted either as the cause or as a law unless it is verified. The verification may be done in various ways. The hypothesis is compared with other established truths or facts. Or certain conclusions are deduced from the hypothesis and the coherence of the new conclusion with other established facts is examined. Verification helps in reaching higher degrees of probability by gradual confirmation of the hypothesis. Without verification a hypothesis has no place in scientific procedure and is useless.

iv) It should usually be consistent with previously established truths or laws:

The hypothesis should not be framed going against the established laws of nature, unless there is the need of an adhoc hypothesis. There are certain laws of facts which are normally unchallengable in nature. For example, every object is extended is an accepted truth. Similarly, like begets like, living beings are mortal, a heavy object does not hang in the air because of the force of gravitation etc. are the exceptionless regularities of nature. They are so to say the laws of the natural world. Any supposition, that violates any such accepted truths becomes itself unacceptable. It does not mean that no law of science or the law of society can not be challenged. But it is suggested that unless there is sufficient ground, a hypothesis should not be framed going against the established truths.

v) A hypothesis should be based on vera causa or real cause. This point suggests that one should be careful against superstitions while framing hypothesis. In this regard the remark of Newton is quite significant that "only real causes are to be admitted in explanation of phenomena". This remark was made to guard against blind beliefs while investigating the cause. For example, sometimes it was thought that the drought occurs due to some supernatural power; or diarrhoea is due to the anger of the village goddess; etc. These suppositions are no doubt unrealistic. So, it is suggested that hypothesis should be realistic or based on vera causa.

vi) A hypothesis should have the power of prediction. A hypothesis should explain not only the present event, but also be capable to explain future events of the same type as well. Then only the veracity of the hypothesis can be accepted. After knowing the cause of solar or lunar eclipse the scientists can make accurate prediction when the next eclipse will occur. On the basis of the predictive power, a hypothesis is accepted as a legitimate one.

vii) A hypothesis should be simple. A simple hypothesis does not involve too much of assumptions. When there are two incompatible hypotheses, the one that is comparatively simpler is accepted. In respect of the path of the planets two hypotheses, namely, the Ptolemic and the Copernican, were offered. Further observations confirmed the hypothesis of Copernicus to be

simpler than that of Ptolemy. So it was accepted. Hence, a hypothesis should be simple.

10.4 PROOF OF HYPOTHESIS :

The entire procedure of induction lacks formal proof and is unable to provide conclusive or absolutely certain conclusion. There can be higher degree of probolilty of the conclusion if it coheres with more and more established facts. Time to time new genralisations are established and accepted. A generalistion is suggested like a hypothesis so there is the need of verification for the confirmation of the hypothesis. Thus, verifiability is the important criterion of a legitimate hypothesis. It is also the most important condition for the proof of the hypothesis.

VERIFICATION OF HYPOTHESIS:

The verification of hypothesis is usually done in two ways, i.e, directly and indirectly. The direct verification takes place through observations or experiments. The indirect method of verification constitutes deduction and comparison with the established laws. The second one is none the less a deductive method because whether the newly formed hypothesis is consistent with other established laws or not is to be tested. When a hypothesis gradually gets confirmation from subsequent facts then it is accepted as proved. This method is considered as proving through accumulation of consistent facts.

DIRECT VERIFICATION :

Where direct verification is possible it takes place either through observation or through experiment. The verification through experiment is more dependable than the verification through observations. Because the verification of a hypothesis should take place in as many cases as possible, otherwise, the chance of being falsified cannot be ruled out. For example, a generalisation like 'Swans are white' if verified at various places in India is not sufficient. In Australia black swans are seen. It shows that observational hypothesis is more vulnerable than experimental ones.

INDIRECT VERIFICATION:

If it is not possible to verify a hypothesis through observation or experiment then the verification takes place by making a comparison with the knowledge of accumulated facts or through a process of deduction from a supposed cause. This later process of verification is considered as the method of indirect verification.

In case of indirect verification the conclusions possible from the supposed cause are verified on the basis of the knowledge of the facts of experience. If the conclusions are found to be true, then the hypothesis is considered to be verified.

In order to prove the supposition that mercury level rises in a barometer due to atmospheric pressure Torricelli went to a mountain top and verified it directly. But Galileo proved the pressure of atmosphere indirectly from the observed facts that two objects with different weight would reach the ground at the same time when dropped from a height.

ADEQUACY

It has already been said that a hypothesis should be adequate. Adequacy is one essential requirement for indirect verification.

A hypothesis is taken to be adequate when it is found to be the only possible one to explain the fact. Ptolemic hypothesis was considered to be inadequate because it would not explain the phenomenon of aberration of light. On the other hand the Copernican hypothesis could explain the facts in a better way through the supposition that the sun is at the centre and the planets move around it. For this reason the Copernican hypothesis was considered to be adequate one. Thus for verification adequate hypotheses are helpful because they can explain the complex phenomena from various angles.

In course of verification of a number of hypotheses in respect of some particular event, there may be the need to select one and reject others on the basis of a special ground. That special ground, which becomes a crucial factor to show right direction to select the correct hypothesis, is known as crucial instance. In case of a cross road, selection of the right direction

is done referring to some vital mark or finger post. Bacon considers a crucial instance to serve like a finger post. A crucial instance, Jevon holds, not only helps in selecting the right one, it also helps in rejecting the irrelevant hypotheses. Crucial instances may be found by simple observations or experiments.

The theory of 'aberration of light' was found to be the crucial instance to justify the Copernican hypothesis in respect of the movement of planets.

Similarly, a crucial factor in case of experiment decides the relevance of reaching at a definite conclusion. Such experiment is called "experimentum crusis". Scientist Raleigh's claim that there is another gas in the air other than nitrogen and oxygen was accepted on the significant experiment where argon could be isolated form air. This is considered to be an example of experimentum crusis.

CONSILIENCE OF INDUCTION

Certain special occurrences are seen in case of the verification of certain hypotheses which are known as consilience of induction. In these cases the hypothesis besides explaining the facts of the concerned hypothesis also explains certain other facts, which were not known.

Newton's law of gravitation besides explaining the gravitational force involved in the falling of hanging bodies also explained the cause of formation of the tides in the sea.

PREDICTION

A hypothesis is proved on the strength of its power of prediction. It has been said that every scientific hypothesis should have the power of prediction. These predictions are not mere guess works. The hypothesis accepts the possibility of certain future facts, which are considered as its predictability. In that case one has to wait till the occurrence of the facts to be verified. An astronomer may propose a hypothesis regarding the appearance of a comet in future. In order to verity it one has to wait till that period. Whewell considers that a hypothesis is often proved by its power of prediction.

In order to be verified the hypothesis should be simple. A simple hypothesis has the advantage of being proved easily and established easily.

SUMMARY

DEFINITION – It is a provisional supposition to explain certain phenomena whose explanation is not known.

CHARACTERISTICS –

i) It attempts at an explanation of puzzled facts.

ii) It suggests a probable cause

iii) Facts are organised in a systematic manner through hypothesis.

iv) Formation of hypothesis is linked with its verification.

CLASSIFICATION –

According to Read – i) Concering agent
ii) Concering collocation
iii) Concering law.

According to Welton-i) of cause
ii) of law

According to Stebbing i) Explanatory
ii) Descriptive
iii) Analogical.

Other forms i) Working hypothesis
ii) Adhoc hypothesis
iii) Non –instantial hypothesis.

CONDITIONS OF LEGITIMATE HYPOTHESIS:

It should not be absurd but precise.

It should not usually go against established truths.

It should be adequate

It should be verifiable

It should be simple and possess predictability.

PROOF OF HYPOTHESIS – It should be Verified directly or indirectly. In verification certain key instances are known as crucial instances.

MODEL QUESTIONS

GROUP- A

Objective Questions :

1. Answer the following :-

i) What is meant by a hypothesis?

ii) State a condition of a legitimate hypothesis.

iii) Give an example of non-instantial hypothesis.

iv) What is an absurd hypothesis?

v) What is the meaning of vera cause?

vi) Give an example of an ad hoc hypothesis.

vii) Name stebbing's classification of hypothesis.

viii) What is a theory?

2. Fill in the blanks:

i) Hypothesis is a _____ supposition. (provisional)

ii) When a hypothesis is verified, it becomes either a _____ or a _____ . (Law, Cause)

iii) Hypothesis should not ordinarily _____ with established theories of scienc. (in conflict)

iv) Hypothesis may be directly verified by _____ and _____. (directly, indirectly)

v) When a crucial instance is obtained by experiment, it is called _____.
(experimentum crusis)

vi) Power of prediction is a _____ of hypothesis. (Strength)

vii) _____ says that an hypothesis must have a predictive power. (Whewell)

viii) _____ said, "Hypothetic non fingo". (Newton)

ix) _____ is considered as vera causa. (Real Cause)

x) _____ hypothesis is framed to explain the discrepancies noticed in case of law or theory. (Ad-hoc)

GROUP-B

Short–type Questions :

1. Write notes on the following.

i) Explanatory hypothesis.

ii) Descriptive hypothesis.

iii) Analogical hypothesis.

iv) Working hypothesis.

v) Adhoc hypothesis.

vi) Non-instantial hypothesis.

vii) Legitimate hypothesis.

2. Answers the following:-

i) What is hypothesis concerning collocation?

ii) What is crucial instance?

iii) What is vera causa?

iv) What is hypothesis concerning law?

v) What is hypothesis concerning agent?

vi) What is representative fiction?

vii) What is conscilience of indcution?

3. Explain with example:-

i) Self-contradictory hypothesis

ii) Unverifiable hypothesis

iii) Fictitious or absurd hypothesis.

GROUP -C

Long-type Questions

1. Define hypothesis and discuss its importance in induction.
2. State and explain the conditions of a legitimate hypothesis.
3. How is a hypothesis proved ? Discuss
4. How are hypothesis, theory, law and fact related? Explain.

***

2. Fill up the blanks.

a) ____ is the root cause of suffering.

b) Ignorance is called bondage but ____ liberates a man.

c) 'There is a cause of suffering' is the ____ noble truth of Buddha.

d) ____ pitaka contains the moral philosophy of Buddha.

e) There is ____ wheels in Dharma chakra / Pratityasamatpada chakra.

f) No-soul theory and momemtariness are corolaries of the doctrine of ____.

g) Jivan mukti is possible in ____ philosophy.

3. Answer in brief.

a) Dharma chakra and Bhava chakra.

b) Nirvana

c) Second noble truth

d) Karma & rebirth.

4. Long type questions.

a) Explain four boble truth of Buddha

b) Explain the doctrine of Pratitya samutpada.

c) What are eight fold paths ? How is it related to four noble truths ? Explain.

SUMMARY

Goutam Buddha is the founder of Buddhism. Buddhist teaching was mainly found in Tripitakas. There are three *Tripittakas*: *Vinaya Pittaka, Sutta Pittaka* and *Abhidamma Pittaka*. Buddha's teaching is mainly concerned with human suffering and his goal is to attain human freedom. His teaching is mainly contained in four noble truth., eight fold paths & dependent origination. The four noble truths are: The life in the world is full of sorrow and suffering (*dukha*). There is a cause of suffering (*dukha samudaya*). There is a cessation of suffering (*dukha nirodha*) and there is a way leading to the cessation of suffering (*dukha nirodha marga*). Theory of dependent origination is based on the second and the third noble truth. Pratityasamutpada or the theory of dependent origination tells us that being troubled by the worldly sufferings, man finds its cause and ultimately we reach at the root cause of all sufferings. Knowledge is the only means of getting *nirvana*. Ignorance is bondage and knowledge is liberation.

MODEL QUESTION

1. Objective type questions

a) Who is the founder of Buddhism ?
b) Who is Rahul ?
c) Where do we find the teachings of Buddha ?
d) How many Tripitakas are these in Buddha's teaching ?
e) How many Noble truths are there ?
f) What is the first noble truth ?
g) What is the 2nd noble truth ?
h) What is the 3rd noble truth ?
i) What is the 4th noble truth ?
j) How many golden paths are there for liberatia ?

5. Six sense organs including mind (*Sadayatana*)
6. Sense Object contact (*Sparsha*)
7. Sense experience (*Vedana*)
8. Thirst for sense experience (*Trsna*)
9. Clinging to this worldly enjoyment (*Upadana*)
10. Will to born (*Bhava*)
11. Rebirth or birth (*Jati*)
12. Old age, death etc. (*Jara Marana*)

Out of the twelve links, the first two are related to past life, the last three are related to future life and the rest are present life. These links shows that we are suffering due to our ignorance of this *bhava chakra* or the *dharma chakra*. Our ignorance is the cause of rebirth and suffering. That is why Buddha says that he who sees dependent origination sees the *dharma* and he who sees *dharma* sees *pratityasamutpada.* This understanding of dependent origination is the key to *nirvana.* The theory of dependent origination is the central teaching of Buddha. Other teachings can be deduced from it. Other teaching like theory of *karma* is one of the corollaries of the theory of dependent origination. *Karma* is mainly blessed on the causal principles of "As you so, so shall you reap." Rebirth is depending on the theory of *karma.* Theory of momentariness or *ksanabhangavada* is also another corollary of dependent origination because everything is momentary, dependent and conditional. So, nothing is permanent. So also the so-called soul is not permanent according to Buddha. The individual soul is ultimately not permanent but relative, it is ultimately false. Nothing is permanent neither body nor mind. The soul is nothing but a series of becoming. Everything is conditional, dependent, relative *pratityasamutpada*.

origination. The second noble truth expresses the cause of suffering. The third noble truth expresses the fundamentals of *pratityasamutpada.* Buddha tries to find out the cause of suffering and how the cause of suffering will be ceased. Thus, that leads a way to the cessation of suffering i.e. the fourth Noble truth. The theory of *pratityasamutpada* is nothing but a theory of causation. According to Goutam Buddha, every event has a cause. Without a cause no event can occur. The causal formula is that depending on the cause, the effect arises. The effect always depends on the cause. The suffering of old age, misery, diseases etc. are due to the birth. So if we will not take birth, then there will be no suffering. So, birth is the cause of suffering. In this connection, Buddha has given an example of a flame in an oil lamp. The flame is dependent upon the oil and the wick. When the oil and the wick are present, the flame in the lamp is present. If either of them is absent, the flame ceases to be present. Similarly, if we stop rebirth, then we will not suffer. Birth is not the final cause of suffering. We take birth because of our willingness to be born, our willingness is due to our clinging to the objects of the world. This clinging towards objects is due to our craving or desire for enjoyment of objects. This enjoyment is due to sense experience. Sense experience is there because of our sense-object contact. This sense object contact is due to our sense organs. We have sense organs because we are psycho-physical organism having body and mind. As we have body and mind we have some initial consciousness of our embryo of the past life. This impression is due to our ignorance. Hence ignorance is the root cause of suffering.

This chain of casual series is called causal wheel or *bhava chakra* or *jaramarana chakra*. This twelve links cover the past, present and future life. These twelve links are:

1. Ignorance (*Avidya*).
2. Impression (*Samskara*)
3. Initial Consciousness of embryo (*Vijnana*)
4. Psychophysical organism (*Namarupa*)

Third Noble Truth:

Dukha Nirodha or cessation of suffering follows from the second noble truth that when cause of suffering i.e. ignorance is removed, the effect i.e. suffering is removed. So, in order to remove suffering or misery from earthly life, Buddha invented a way to get rid of suffering. That is the fourth noble truth.

Fourth Noble Truth:

The fourth noble truth is a way leading to this cessation of suffering (*Dukha nirodha marg pratipad*). According to Goutam Buddha, too much of attachment towards worldly objects is very much painful. But a man cannot live without worldly objects. It is very difficult on the part of human being to be detached from these worldly objects and become a *sanyasi.* It is very difficult on the part of human beings to give away all worldly objects and become sanyasi. Neither too much materialistic nor too much spiritualistic is possible. So, Buddh suggests a third or the middle path to get *nirvana*. He recommended eight fold paths for attainment of *nirvana*. It is for all sections of the people irrespective of cast, colour, creed and sex. One can grow into the state of perfection if he follows the eight fold path i.e. *samyak vak* (right speech), *samyak akrmanta* (right action), *samyak smruti* (right mindfulness), *samyak jiva* (right livelihood), *samyak vakyama* (right effort), *samyak samadhi* (right concentration) *samyak drusti* (right view) and *samyak sankalpa* (right understanding). These are the moral teachings which show the right path for making a human being morally perfect.

11.3.2 DEPENDENT ORIGINATION (*PRATITYASAMUTPADA*)

Theory of dependent origination or *pratityasamutpada* is the most important part of the teachings of Buddha. There is a close relationship between four noble truth and dependent

11.3.1 THE FOUR NOBLE TRUTHS

1. The life in the world is full of sorrows and suffering (*Dukha*).

2. There is a cause of suffering (*Dukha Samudaya*).

3. There is a cessation of suffering (*Dukha Nirodha*)

4. There is a way leading to the cessation of suffering (*Dukha Nirodha Marga*).

First Noble Truth:

Buddha's first noble truth states, a fundamental feature of all suffering. It is stated by Buddha that: "Birth is a suffering, old age is suffering, sickness is suffering, death is suffering, to be separated from the loved one is a suffering, to be united with unloved is a suffering, not to obtain what one desires is suffering, in short the fivefold clinging to the Earth is suffering." So, for him, the cycle of birth and death is nothing but suffering. The cycle goes on unless one escapes from it by attaining enlightenment, the state of *Nirvana*.

Second Noble Truth:

The second Noble Truth is that there is a cause of suffering (Dukha Samudaya). From this second Noble Truth his three fundamental theories are derived. The three fundamental ideas of early Buddhist metaphysics are the theory of *Partityasamutpada*, the theory of Ksanabhangavada or the theory of momentariness and the theory of *Anantmavada* or the theory of no soul. The theory of dependent origination (*pratityasamutpada*) explains that the phenomena in the world are related to a causal flux. Everything is conditional, relative and limited. So, suffering must have a cause. It must be dependent on some condition Since everything is conditional, cause being present, the effect arises and the absence of the cause the effect remains absent. The cause of suffering is ignorance. Suffering stops at the dawn of knowledge.

11.3 BUDDHISM

Goutam Buddha is the founder of Buddhism. He was born in a Royal family during sixth century B.C and had a son named Rahul. In spite of all pleasures and comforts of royal life and a loving family he left home to find out the causes of human suffering. Three incidents like the sight of a sick man, a tottering old man and a *sanyasi* made him pensive. He strove to find a solution to the problem of worldly worries & sufferings. He took the help of many religious teachers and preceptors but could not find the ultimate truth. Finally, he meditated under the banyan tree at Bodhgaya to get enlightenment. Prince Siddhartha became the enlightened Buddha. After getting true knowledge he decided to share it with the World through his followers.

Buddha's teaching was oral. After his demise several attempts were made to codify his teachings. The teachings of Buddha were mainly contained in *Tripitakas*. It is otherwise known as three baskets of knowledge. These three *Tripitakas* are *Vinaya Pittaka*, *Sutta Pittaka* and *Abhidamma Pittaka*. *Vinaya Pittaka* contains the rules for his monks, Sutta Pittaka contains the principal theories or dialogues and the Abhidhamma Pittaka contains the Philosophical theories of Buddha.

Buddha was a rebel against priestly culture. He was a believer in the theory of *Karma*. He was not a metaphysician believing in the existence of soul. On the other hand he believes in rebirth. The theory of *Karma*, rebirth and efficiency of knowledge were the instrument for attainment of salvation or *mukti*. The central teaching of Buddha is that it is possible to end suffering. One who is free from suffering attains nirvana or salvation. Buddha is deeply concerned with human suffering and his only goal is human freedom. So his sound teaching is that a knowledgeable man instead of wasting his time in idle enquiry about soul, world, God etc. should concentrate on overcoming human suffering and attaining the goal of *nirvana*. So he remains silent about all metaphysical questions. He rather prefers to show the way to the practical problems of eradicating suffering. The main philosophy of Buddha is contained in four Noble Truths and Eight Noble Paths. The four Noble Truths are:

3. Short type questions

(Write in three to five sentences as far as practicable)

a) Why Jaina theory of knowledge is called syadvada ?

b) What is the meaning of anekanta vada ?

c) Why Jaina metaphysics is called pluralistic realism ?

d) Why Jaina metaphysics in called realistic ?

e) Who is a kevaljnani in Jainaism ?

f) What are the positive and negative qualities of an object ?

4. Essay type questions

a) Explain Jaina view of syadvada

b) Discuss Jaina doctrine of Anekantavada.

MODEL QUESTIONS

1. Objective type questions

a) Do the Jainas accept the authority of the Vedas ?

b) What is the meaning of syad in Jainism ?

c) What is the meaning of syadavktvyam ?

d) What is the meaning of syadasti ca nasti ca in Jainism ?

e) What is known as the metaphysical doctrine of Jainism ?

f) What does anekantavada mean ?

g) Does Jaina theory of knowledge accept scepticism ?

h) What is the meaning of 'ananta dharmakam vastu" ?

i) Do the Jainas believe in matter and soul ?

j) Do the jainas believe in a supreme God ?

2. Fill up the blanks :

a) Jainism belongs to ___ school of Indian Philosophy.

b) The word 'jina' means ____.

c) ___ is the founder and first tirghankar of Jainism.

d) ____ is the last tirthankar of Jainism.

e) Mahaveer is a contemporary of the great philosopher ____.

f) Jaina theory of knowledge is called ___.

g) Jaina theory of reality is called ___.

h) Jaina theory of syadvada is ___ realism.

i) Jaina theory of anekantavada is realistic ___.

j) Jaina metaphysics in realistic ___.

k) According to Jainism objects have both positive and ___ qualities.

SUMMARY

Jainism belongs to the heterodox (nastika) schools of Indian Philosophy. The word 'Jaina' in derived from the word 'jina' which means the conqueror. 'Conqueror' refers to the liberated who has conqured all passions. Vardhaman who is known as Mahaveer was the last and most influential tirthankar.

Jainism does not believe in a supreme God but accepts 'soul' and 'matter'. Jainism has epistemological (Jnana mimamsa), metaphysical (Tattva Mimamisa) and ethical (neeti mimamsa) aspects.

Syadvada is jaina theory of knowledge. Knowledge is relative in the sense that one can know from a particular aspect or point of view.

'Syad' means 'may be' or 'some how'. Syadvada is known as 'saptabhangi naya' which means seven forms of relative knowledge. They are (1) syadasti (may be a thing is real) (2) syadnasti (May be a thing is unreal (3) syadastica nasti ca (May be a thing in both real and unreal (4) Syadavktayam (May be a thing is indescribable) (5) Syadasti ca a vaktavyam (May be a thing is real and indescribable) (6) Syadnasti ca avaktavyam (May be a thing is not real and indescribable) (7) syadasti ca nastica avaktavyam (May be a thing real, unreal and indescribable). Jainism is not to be understood as a kind of scepticism. It says that our judgements are relative and conditional but not uncertain and doubtful.

Anekantavada is Jaina metaphysics of multiplicity of reality. It is called 'ananta dharmakam vastu which means objects have innumerble characters (dharma). It is realistic pluralism as it accepts manyness of reality as well as accepts the existence of substances independently. Jaina theory of knowledge is derived from its theory of reality. The theory that objects have innumerable qualities we derive the theory that one can not know all the qualities of a thing so only an omniscient (kevalajnani) can know all the qualities of all things.

Jaina anekanta vada and syadvada are catholic in nature as they accept that the contrary views of Buddhism and Brahminism are acceptable as they are only from different perspectives.

11.2.2 Anekanta Vada

Anekantavada is the metaphysical doctrine of Jainism. It is called 'ananta dharmakam Vastu' which means every object has innumerable qualities or characters (Dharma or guna). In other words anekantavada is the theory of multiplicity of reality. Every object has both positive and negative characters. The positive characters of a thing like table are its shape, size, form, weight, composition, colour, height, length, breath and so on. It has also the negative characters. The negative characters of a table are those characters which a table does not have. A table is not a chair, not a fan, not rounded, not wooden etc. The negative characters are those which distinguishes the object from all other objects. Besides the positive and negative characters the object has innumerable relations to all other objects. These relations also constitute the characters. Further more the object acquires new characters in course of time. Thus the object has infinite characters.

Jaina metaphysics is realistic pluralism. It is pluralistic as it accepts manyness of reality and it in realistic as it accepts the existence of substance independently. Jaina theory of knowledge is relativistic in the sense that our judgement is always from one particular stand point or aspect. We can not know anything absolutely.

Syadvada and Anekantavada are reciprocal. From Jaina metaphysical theory that every object has innumerable qualities or characters we derive the theory of knowledge that one can not know all the qualities or characters of a thing. So we can know something about something. An omniscient (kevalajnani) can know all the characters of all the things.

Jaina anekantavada makes an exposition of the one sided theories of Brahminism and Buddhism. Reality for Brahminism in one permanent and real where as it is plural, changing and impermanent as well as unreal according to Buddhism. Jainism clarifies that both are true from different aspects and perspectives. To consider a partial or one sided view as the whole truth is misleading. Jaina doctrine of syadvada and anekantavada is in a midway between two opposite schools like Buddhism and Brahminism. Thus it is considered as more Catholic and tolerant as a religion.

2) Syad nasti (May be a thing is unreal) It means some how a thing does not exist. For example "May be a table does not exist". The table does not exist in other matter, in other time, or in other form. It is not there as a pen or a chair or whatever is not a table.

3) Syad astica nasti ca (May be a thing is both real and unreal. It means a thing exists and does not exist depending on different points of views. So it is not a contradiction. The table exists as a table but does not exist as any thing which is not a table.

4) Syad avaktayam (May be a thing is indescribable or inexpressible). This is the fourth kind of judgement according to Jainism. An object can not be described as a whole. For example, a leaf is green, then it becomes yellow, then brown and also its shape, size changes in course of time and spatial locations. So it can not be described without a stand point or aspect.

5) Syad asti ca avaktavyam (May be a thing is real and indescribable). The object exists from one stand point but from all points of view or from all aspects it can not be describable.

6) Syad nasti ca avaktavyam (May be a thing is not real and indescribable). A thing is relatively or from a Particular stand point said to be unreal and indescribable.

7) Syad asti ca nastica avaktavyam (May be a thing is real, unreal and indescribable.

The doctrine of syadvada is some times misunderstood as a kind of scepticism or agnosticism. Sceticism is doubting what is beleived to be true. Agnosticism is the doctrine that reality is unknown and unknowable . In Jainism the word syat is understood to mean 'may be'. Here by may be we mean that our judgements are relative and conditional but not that they are uncertain or doubtful.

relativity of judgement. For example when we make a perceptual judgement like 'This is a tree' we may be mistaken. But if we say, 'May be this is a tree" we can not be mistaken. So, according to jainism we should prefix 'may be' when we make judgements about objects. The judgement that 'This is a tree' is relative in the sense that in one aspect this in a tree. But there can be innumerable aspects from which the tree can be looked at and be judged. In this context the jainas give the example of the story of 'six blind men and the elephant'. Each of the blind men touched a part of the elephant and described about the elephant as a whole. The man who touched the ear said, the elephant is like a country made fan, the man who touched the tail said it is like a rope, the man who touched the trunk said it is like a huge snake, the man who touched the side of the animal said it is like a wall and so an. The blind men were in conflict with each other due the fact that each of them has mistaken a part of the elephant to be the elephant as a whole. So our judgements are only partially and conditionally true because the judgements are made from a particular point of view and a particular aspect.

Saptabhangi Naya

Syadvada is known as sapta bhingi naya. According to jainas there are seven forms of relative judgements. Naya means the judgement which in a proposition about knowledge of object. Jainas prefix syad ('may be' or 'some how') before every judgement as the following.

1) Syatasti (May be a thing is real). This means, "a thing exists relatively or from a particular point of view." For example, the judgement that 'May be a table exists" means the table does not exist absolutely. The table which we can know has innumerable characters (gunas). We can know the table of a particular shape, size, colour in a particular space and time. So "the table exists" is partially and conditionally known to be true from one aspect and under some conditions.

11.2 JAINISM

Jainism is an ancient religion as well as a school of philosophy. It is one of the three heterodox (nastika) schools of Indian Philosophy. The word 'jaina' is derived from the word 'jina' which means the conqueror or victor. In the context of Jainism 'jina' refers to conqueror of all possessions and thus he is the one who is liberated. All the twenty four tirthankars of Jainism are said to have attained liberation. Rsabhadeva was the first founding prophet and teacher (tirthankar) of Jainism. Parsvanath and Vardhamana (who is known as Mahaveer) were the last two tirthankars. All the tirthankars have contributed to the growth and expansion of Jainism. However Mahaveer is considered as the last and the most influential tirthankar who reformed Jainism. Mahaveer was a contemporary of Goutam Buddha.

Jainism like Buddhism does not accept the authority of the vedas. It does not believe in a supreme God. But unlike Buddhism it accepts the permanent entities like 'soul' and 'matter'. Jainism has three important aspects. They are epistemology (theory of knowledge) which is called 'jnana mimansa', metaphysics, which is or 'Neetisastra' called 'tatva mimamsa and ethics. Jaina theory of knowledge is relativistic and its theory of reality (metaphysis) is plurastic realism. As a whole jaina philosophy is relativistic and realistic pluralism. Jaina theory of knowledge is called anekantavada and its theory of reality is called syadvada. Syadvada and Anekanta vada are two important and mutually reciprocal doctrines of Jainism.

11.2.1 Syadvada

Syadvada is known as Jaina theory of knowledge. The word 'syat' in sanskrit means 'may be', 'probable or 'perhaps'. According to Jainism our knowledge is relative. Our knowledge of an object is always from a particular point of view and from a particular aspect. We can not know an object as a whole. Our knowledge is conditional, partial and limited. Knowledge is expressed in propositions or judgments. So Syadvada is called the theory of

2. Fill up the blanks :

a) Those who believe in the authorities of the vedas are called _____.

b) Those who do not believe in the authorities of the Vedas are ____.

c) The end part of Vedas is called ____.

d) Vedanta is known as ____.

e) One receives the consquenes of his action is the dectrine of ____ in Indian philosophy.

f) To get liberation during the present life is called _____.

g) To get liberation after death is called _____.

h) Indian philosophy is called ____ as it points out misery and sorrow in human life.

3. Short type questions

a) Write the names of the six schools of Indian philosophy.

b) Which of the schools of Indian philosophy are called Orthodox (Astika) darshana.

c) Which schols of Indian philosophy are heterodox or nastikas.

d) State the purusarthas in Indian Philosophy.

e) What are the different kinds of liberation.

f) State the basic doctrine of karmavada.

g) Why the notion of rebirth is accepted by Karmavada.

4. Essay or long type questions

a) Discuss the characteristics of Indian philosophy.

b) Discuss the doctrine of karma in Indian Philosophy.

c) Is Indian Philosophical out look towards life pessimistic ? Discuss.

SUMMARY

All most all the systems of Indian Philosophy except the Carvakas share some common characteristic. Development of Indian philosophical thought in different stages and phases is marked by dialogues in the form of arguments. It is philosophy of life which is of greater concern for Indian thinkers than more intellectual curiosity. Philosophy should aim at promotings an individual to realise purusarthas (the supreme ends of life). All the schools of thought emphasise sorrow and suffering misery and ignorance as evils. The ultimate aim of human life is liberation, freedom (mukti) or moksa. Moksa can be attained here and now like the state of jeevan mukti or a stitapragna. Moksa is also a state of enlightenment where ignorance is completely destroyed.

All most all the schools beleive in Karmavada and rebirth as a Universal moral order. All systems recognise the fundamental spirituality of human being. **Pessimission** in Indian Philosophy is optimistic and pragmatic.

MODEL QUESTIONS

1. Objective type questions

a) Name one of the orthodox (astika) school of Indian Philosophy ?

b) The word darasana is derived from which Sanskrit word ?

c) What is tattvajnana known as ?

d) Name one of the heterodox (Nastika) schools of Indian Philosophy

e) What is called parama purusartha in Indian Philosophy ?

f) What is called the eternal and inviolable cosmic and moral law in Indian Philosophy ?

g) What is the name of liberation in Buddhism ?

h) What is prarabdha Karma ?

i) What is anarabdha karma ?

j) What is videha mukti ?

k) What is jeevan mukti ?

is characterised by self-denial and total renunciation of personal interest. The obligation of the individual also goes beyond society and extended to the **senescent** world. The spirit of Indian moral Philosophy is devotion to duties rather than assertion of rights. Thus an ascetic life of renunciation is the means for the attainment of moksa.

Indian Philosophical out look towards life and existence appears to be pessimistic and negative. This is due to the fact that Indian Philosophical systems emphasise the negative sides of human life. It points out the evils like misery, sorrow, suffering egoism and greed in human life. But this pessimism is only initial, it is not final. This pessimism is a spring board for higher optimism and pragmatism. Indian philosophy, unlike western philosophy, does not start with wonder and intellectual curiosity rather than the problems of real life. It is concerned with these problems of practical life and makes an attempt to solve these problems. It does not conclude that life is a tragedy. It tries to overcome the evil of sorrow and sufferings. The Upanisad declares, "anandadhyeba khalu imani bhutani jayante, anandena, jatani jecbanti, anandam prayantyaabhi sanghishanti." This means this world is originated from bliss, sustained by bliss and dissolved in bliss. Man has the power to over come ignorance, darkness and bondage. The main concern of Indian thinkers, is sat-chit-ananda. 'Sat' means 'existence', 'chit' means 'consciousness' and 'ananda' means 'bliss' which is characterised by knowledge, wisdom and freedom. The famous verse exemplifies the inner optimism of Indian thought. The verse is "asato ma sat gamaya, tamaso ma jyotirgamaya and mrutoma amrutogamaya." This means let me go from false hood to truth, from darknes to light and from mortality to immortality.

Buddha finds out four noble truths. Firstly he admits the truth that there is suffering in human life. Sceondly he points out the truth that there is a cause of suffering. Thirdly he assures that there is a cessation of suffering. Fourthly he shows the truth that there is a way to stop suffering. These four truth claims of Buddha promises hope and optimism.

Moksa or liberation is considered as the ultimate goal of life by all most all schools of Indian Philosophy. Libration is called 'niravan' in Buddhism, 'Kaivalya' in Samkhya and Yoga Philosophy, apabarga in Nyaya Vaisasika philosophy and moksa or mukti in all classical philosophical literature like Vedanta. According to Max Muller, "Philosophy was recommended in India, not for the sake of knowledge, but for the highest purpose that man can strive after in this life. *Liberation is the ultimate purusaratha. It (moksa) is the highest value (paramapurusatha). 'Moksa' and 'Dharma' or 'righteousness' are higher values and 'Artha' and 'Kama' are lower values. It is freedom (mukti) from Physical and moral evil in life. The evil is bondage and sufferings. 'Bondage' is commonly understood as the cycle of birth-death and rebirth which leads to human misery and suffering. So 'mukti' means freedom from this cyclical process of worldly life (Samsara). Ignorance is the root cause of all evil and sufferings of man which is due to his attachment. So knowledge of reality (tattvajnana) is the state of moksa. Though the concept of moksa and attainment of moksa varies from system to system yet all most all the systems agree that knowledge of reality (tattvajnana) can remove ignorance and misery. According to Advita Vedanta Philosophy moksa is a state of ultimate bliss. It is wrongly understood that one can attain moksa after death. On the contrary most of the Indian Philosophical schools teach that it can be attained here and in this life. This is described as 'jeevan-mukti'. So Indian Philosophy is not other worldly in the sense that it seeks happiness, bliss and moksa in an hypothetical imaginary world beyond this life and this world. The state of stithaprajna in Geeta and Jevan Mukti in Vedanta are the states of enlightenment of an individual. Except carvaka all other schools believe in moksa.

Asceticism is a common characteristic of Indian Philosophy. To attain moksa one must follow rigorous self discipline and a life of **renunciation**. **Renunciation** is understood as freedom from attachment and bondage with worldly objects. It is not renunciation of action, duty or responsibility. Some schools emphasise absolute detachment while others prescribe ascetic life at the end of grahyasta life; i.e. during sanyasa and banaprastha asrmas. Indian moral philosophy

* F.Max Muller - six systems of Indian Philosophy, collected works - vol- XIX - P. 370

optimism in Indian Philosophical out look towards life. It is to be noted that the idea of rta was subsequently transformed into the idea of karmavada in Indian moral Philosophy, 'apurva' in Purba mimamsa and the idea of 'adrista' in Nyaya Philosophy.

Karmavada is one of the general characteristic of Indian philosophy. By 'law of Karma' we mean that a person has to receive the consequences of his deeds or actions. All actions, evil or good, produces its effect without fail. One can never escape the law of karma. The central meaning of Karmavada is that one must get the fruits of one's action and no one will get the fruits of any action which is not his own. Good action brings good results and consequence of bad action is always bad. Karmavada explains why some people are happy and others are unhappy, some are healthy and others are not healthy. It explains why good things happen to bad people. It pre-supposes the doctrine of 'rebirth' to explain the present conditions of human life. A good man is suffering due to some bad action of his previous life. His good action will bring good results either in this life or after this life. So all actions of past, present or future must produce their respective results in the present life or in the future life of the individual. As no action goes unrewarded (a positive reward or a negative reward) an individual either enjoys the fruits of his action in this present life or in another life.

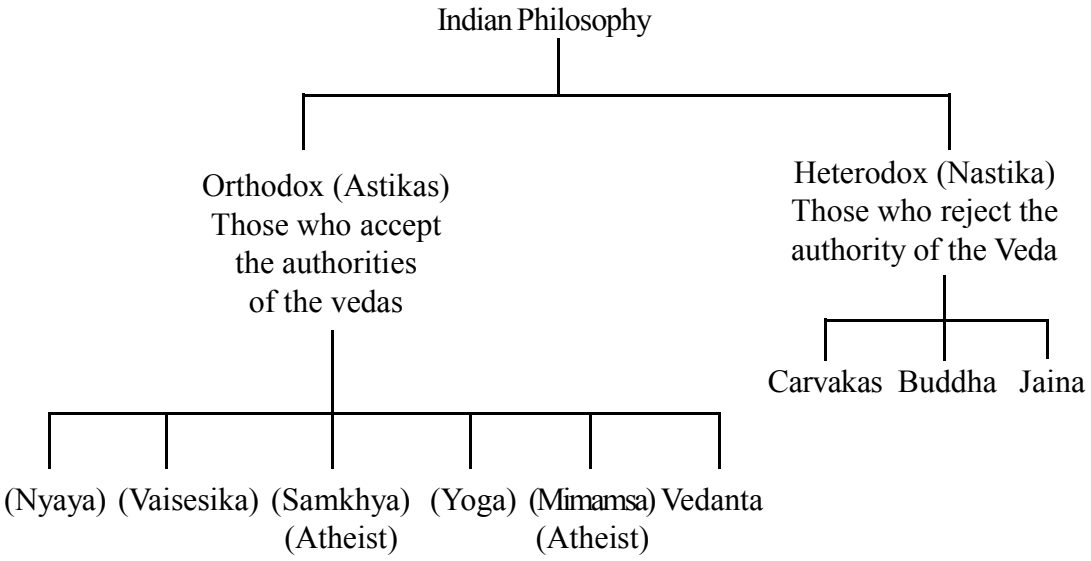
Actions (Karmas) are classified on the basis of the accurrence of their respective results or consquences. Karmas are broadly classified as 'anarabdha' karma and 'Prarabhda' karmas. Anarabdha karmas are those karmas which have not yet produced their results. These karmas are of two kinds. They are either accumulated karmas of this life (Kriyamana or sanciyamana karma) or accumulated from past lives (sancita karma). On the other hand the prarabdha karmas are those actions (karmas) which have started giving fruits in this life. The law of karma can be described as a law of conservation of moral values. In Indian Philosophical literature (except the carvakas) we find both the 'Law of Karma' and 'rebirth' as most fundamental principles which have influenced all the schools of thought and ordinary people.

11.1 COMMON CHARACTERISTICS OF INDIAN PHILOSOPHY

It is difficult to find out the characteristics of Indian Philosophy as a whole due to the diversity of its development. Indian thought is characterised by an argumentative tradition. The dialogue between the orthodox and heterodox schools as well as the dialogue between the different schools within the same systems are quite evident. All the schools have their original and independent views which were developed by way of critical appreciation of each others thought. In this tradition a Philosopher has to follow three points while presenting his view. Firstly, he has to state and give an exposition of the earlier view (purvapaksa). Secondly he states the criticism or refutation (Khandana) of the earliers view. Thirdly he gives his concluding view (Uttarpaksa or Siddhanta).

Indian Philosophy is generally characterised as spiritualistic where as western philosophy is called materialistic. It believes in the reality of the soul and its union with the Supreme soul. Self realisation is the ultimate goal. Except Carvaka school of Philosophy all other schools, either heterodox or orthodox, theistic or athesistic, are spiritual as well as mystical. They value spiritual way of life more than materialistic way of life. They are not satisfied with the pursuit of whatever is merely mundane. They emphasise the realisation of the self. The ultimate aim is the union of the individual self with the universal or supreme self. However from this it can not be concluded that Indian Philosophy is spiritual as a whole and western philosophy is materialistic as a whole. Both the trends of spiritualism and materialism are found in both the Western and Indian traditions. However the spiritualistic character of Indian Philosophy is predominant in all schools except the Lokayatas or Carvakas. Most of the schools believe in a cosmic and a moral order. This moral and cosmic law is eternal and inviolable. This is the Vedic concept of rta. Rta represents the basic truth, harmony and an eternal inviolable moral order of the entire Universe. This concept is moral as well as metaphysical. The Vadic Goods not only maintain and sustain the cosmic order but also preserve and uphold the moral order. The faith in such cosmic and moral order also signifies

Indian Philosophy is known to be the most ancient so far the early vedas and upanisads are concerned. Prof. Hiriyana distinguishes between two phases of Indian Philosophy. The Vadic period and the classical or Sanskrit period. Most of the works of the vedic period are considered as revealed. They are either ritualistic (Karmakanda) or speculative (Jnana) in character. The ritualistic aspect was highlighted by Mimamsa where as the Vedanta or Upanisads emphasised the speculative aspects. Vedanta is the final part of Veda. Indian Philosophical systems are broadly classified in to two kinds of schools. They are the orthodox (astika) and the heterodox (nastika) schools. The schools which accept (or did not reject) the authority of the vedas are called astika schools, like the Mimamsa, Vedanta, Samkhya, Yoga, Nyaya and Vaisesika. On the other hand the schools which do not accept the authority of the Vedas are called nastikas or heterodox schools of Philosophy. They are the Carvakas, Budha and Jaina schools of thought. The classification of different orthodox and heterodox systems in Indian Philosophy can be easily understood from the following table.



CHAPTER - 11
INDIAN PHILOSOPHY

INTRODUCTION :

The term 'Indian Philosophy' means different philosophical systems and traditions originated in the soil of India. By 'Indian Philosophy' some thinkers mean 'Hindu Philosophy'. This is true if by Hindu we mean the inhabitant of a geographical territory (the bank of river Sindhu). But this is not true if by 'Hindu' we mean the adherents of a particular religious faith. Indian Philosophy is called 'darshana'. The word 'darshana' is derived from the Sanskrit word 'dris' which means to see. Darshana is that by which it is seen, known, understood and ultimate wisdom is realised. By 'darshana' we mean tattva darshana vision of truth' or intuitive vision. We generally translate 'darshana' as 'Philosophy' due to a great deal of resemblance between the two. But the word Philosophy is derived from the Greek word 'Philos' and 'Sophia' which mean 'Love' and 'Wisdom' respectively. Philosophy means love of wisdom or knowledge. In Western tradition Philosophy is considered as an art of wondering and it begins with intellectual curiosity.

The term 'darshana' can be better understood in the context of Nyaya darshana. The Nayayikas use the word 'anveeksikee' to mean arrival at truth by logical means of investigation. Darshana is to be understood as a means of extraordinary knowledge in the sense that it designates Jnana, Prajna, Vidya and Paravidya.