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NCERT Class 11- Math's: Chapter – 14 Mathematical Reasoning Part 1

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14.1 Overview

If an object is either black or white, and if it is not black, then logic leads us to the conclusion that it must be white. Observe that logical reasoning from the given hypotheses can-not reveal what “black” or “white” mean, or why an object can-not be both. Infact, logic is the study of general patterns of reasoning, without reference to particular meaning or context.

14.1. 1 Statements

A statement is a sentence which is either true or false, but not both simultaneously. **Note:** No sentence can be called a statement if

- (i) It is an exclamation
- (ii) It is an order or request
- (iii) It is a question
- (iv) It involves variable time such as ‘today’ , ‘tomorrow’ , and ‘yesterday’ etc.
- (v) It involves variable places such as ‘here’ , ‘there’ , ‘everywhere’ etc.
- (vi) It involves pronouns such as ‘she’ , ‘he’ , ‘they’ etc.

Example 1

- (i) The sentence

‘ New Delhi is in India; is true. So it is a statement.

- (ii) The sentence

“Every rectangle is a square” is false. So it is a statement.

- (iii) The sentence

“Close the door” can-not be assigned true or false (Infact, it is a command) . So it can-not be called a statement.

- (iv) The sentence

“How old are you?” can-not be assigned true or false (In fact, it is a question) . So it is not a statement.

- (v) The truth or falsity of the sentence

“ x is a natural number” depends on the value of x . So it is not considered as a statement. However, in some books it is called an open statement.

Note: Truth and felicity of a statement is called its truth value.

14.1. 2 Simple statements A statement is called simple if it can-not be broken down into two or more statements.

Example 2: The statements

“2 is an even number” ,

“A square has all its sides equal” and

“Chandigarh is the capital of Haryana” are all simple statements.

14.1. 3 Compound statements: A compound statement is the one which is made up of two or more simple statements.

Example 3: The statement

“11 is both an odd and prime number” can be broken into two statements

“11 is an odd number” and “11 is a prime number” so it is a compound statement.

Note: The simple statements which constitutes a compound statement are called component statements.

14.1. 4 Basic logical connectives there are many ways of combining simple statements to form new statements. The words which combine or change simple statements to form new statements or compound statements are called Connectives. The basic connectives (logical) conjunction corresponds to the English word ‘and’ ; disjunction corresponds to the word ‘or’ ; and negation corresponds to the word ‘not’ .

Throughout we use the symbol ‘ \wedge ’ to denote conjunction; ‘ \vee ’ to denote disjunction and the symbol ‘ \sim ’ to denote negation.

Note: Negation is called a connective although it does not combine two or more statements. In fact, it only *modifies* a statement.

14.1. 5 Conjunction If two simple statements p and q are connected by the word ‘and’ , then the resulting compound statement “ p and q ” is called a conjunction of p and q and is written in symbolic form as “ $p \wedge q$ ” .

Example 4: Form the conjunction of the following simple statements:

p : Dinesh is a boy.

q : Nagma is a girl.

Solution The conjunction of the statement p and q is given by

$p \wedge q$: Dinesh is a boy and Nagma is a girl.

Example 5 Translate the following statement into symbolic form

“Jack and Jill went up the hill.”

Solution The given statement can be rewritten as

“Jack went up the hill and Jill went up the hill”

Let p : Jack went up the hill and q : Jill went up the hill.

Then the given statement in symbolic form is $p \wedge q$.

Regarding the truth value of the conjunction $p \wedge q$ of two simple statements p and q , we have

(D_1) : The statement $p \wedge q$ has the truth value T (true) whenever both p and q have the truth value T.

(D_2) : The statement $p \wedge q$ has the truth value F (false) whenever either p or q or both have the truth value F.

Example 6 Write the truth value of each of the following four statements:

(i) Delhi is in India and $2 + 3 = 6$.

(ii) Delhi is in India and $2 + 3 = 5$.

(iii) Delhi is in Nepal and $2 + 3 = 5$.

(iv) Delhi is in Nepal and $2 + 3 = 6$.

Solution: In view of (D_1) and (D_2) above, we observe that statement (i) has the truth value F as the truth value of the statement “ $2 + 3 = 6$ ” is F. Also, statement (ii) has the truth value T as both the statement “Delhi is in India” and “ $2 + 3 = 5$ ” has the truth value T.

Similarly, the truth value of both the statements (iii) and (iv) is F.