

CLASS XI

PERMUTATIONS & COMBINATIONS

1. Factorial

Definition: The factorial of a natural number n , written as $n!$, is the product of all positive integers from 1 to n .

$$n! = n(n - 1)(n - 2) \dots 3 \times 2 \times 1$$

Important property:

$$0! = 1$$

$$n! = n(n - 1)!$$

Examples:

$$5! = 5 \times 4 \times 3 \times 2 \times 1 = 120$$

$$7! = 5040$$

$$8! = 8 \times 7!$$

Useful simplification:

$$8! / 6! = (8 \times 7 \times 6!) / 6! = 56$$

Trick: Factorial means multiply backwards up to 1.

2. Principle of Addition

Statement: If an event can occur in m different ways and another event can occur in n different ways, and the two events cannot occur together, then either event can occur in $m + n$ different ways.

$$\text{Total number of ways} = m + n$$

Example: A student can travel to school by 3 bus routes or 2 train routes. Assuming the choices are separate, the number of ways is:

$$3 + 2 = 5$$

OR $\rightarrow$ Add.

3. Principle of Multiplication

Statement: If one event can occur in m different ways and, after it has occurred, a second event can occur in n different ways, then the two events in succession can occur in $m \times n$ different ways.

$$\text{Total number of ways} = m \times n$$

Example: If there are 3 shirts and 2 trousers, the number of ways of choosing one shirt and one trouser is:

$$3 \times 2 = 6$$

AND $\rightarrow$ Multiply.

4. Permutations

Meaning: A permutation is an arrangement of objects in which order matters.

Example: The arrangements ABC and BAC are different because their order is different.

Theorem of Permutations

The number of permutations of n different objects taken r at a time is:

$${}^n P_r = n! / (n - r)!$$

5. Combinations

Meaning: A combination is a selection of objects in which order does not matter.

Example: AB and BA represent the same selection when two objects are chosen.

Formula of Combination

$${}^n C_r = n! / [r!(n - r)!]$$

Since the r selected objects can be arranged in $r!$ ways, each combination corresponds to $r!$ permutations.

$${}^n C_r = {}^n P_r / r!$$

$$\text{Therefore, } {}^n C_r = n! / [r!(n - r)!]$$

6. Permutation vs Combination

Point	Permutation	Combination
Meaning	Arrangement	Selection
Order	Matters	Does not matter
Formula	${}^n P_r = n!/(n-r)!$	${}^n C_r = n!/[r!(n-r)!]$
Example	Arranging students	Selecting students
AB and BA	Different	Same

7. Recall

Successive events → Multiplication → AND

Mutually exclusive alternatives → Addition → OR

Arrange → Permutation → Order matters

Select/Choose → Combination → Order does not matter