**1.Multiplication Theorem (Fundamental Principles of Counting)**If an operation can be performed in **m** different ways and following which a second operation can be performed in **n** different ways, then the two operations in succession can be performed in **m×n** **different ways**.  
  
**2. Addition Theorem (Fundamental Principles of Counting)**  
If an operation can be performed in **m** different ways and a second independent operation can be performed in **n** different ways, either of the two operations can be performed in **(m+n) ways**.  
  
**3. Factorial**  
Let n be a positive integer. Then n factorial can be defined as

**n!=n(n−1)(n−2)⋯1**

**Examples**  
5!=5×4×3×2×1=120   
3!=3×2×1=6

**Special Cases**  
0!=1  1!=1

**4. Permutations**

Permutations are the different arrangements of a given number of things by taking some or all at a time.  
**Examples**

* All permutations (or arrangements) that can be formed with the letters a, b, c by taking three at a time are (abc, acb, bac, bca, cab, cba)
* All permutations (or arrangements) that can be formed with the letters a, b, c by taking two at a time are (ab, ac, ba, bc, ca, cb)

**5. Combinations**

Each of the different groups or selections formed by taking some or all of a number of objects is called a combination.  
**Examples**

* Suppose we want to select two out of three girls P, Q, R. Then, possible combinations are PQ, QR and RP. (Note that PQ and QP represent the same selection.)
* Suppose we want to select three out of three girls P, Q, R. Then, only possible combination is PQR

**6. Difference between Permutations and Combinations and How to identify them**Consider a situation where we need to find out the total number of possible samples of two objects which can be taken from three objects P, Q, R. To understand if the question is related to permutation or combination, we need to find out if the order is important or not.

* If order is important, PQ will be different from QP, PR will be different from RP and QR will be different from RQ
* If order is not important, PQ will be same as QP, PR will be same as RP and QR will be same as RQ

Hence,  
**If the order is important, problem will be related to permutations.   
If the order is not important, problem will be related to combinations.**

**7. Repetition**  
The term repetition is very important in permutations and combinations.

Consider the same situation described above where we need to find out the total number of possible samples of two objects which can be taken from three objects P, Q, R.

* If repetition is allowed, the same object can be taken more than once to make a sample. i.e., PP, QQ, RR can also be considered as possible samples.
* If repetition is not allowed, then PP, QQ, RR cannot be considered as possible samples.

**\***Normally repetition is not allowed unless mentioned specifically.

**8. Number of permutations of n distinct things taking r at a time**  
Number of permutations of n distinct things taking r at a time can be given by

**nPr = n! / (n-r)!**

**Examples**  
8P2 = 8 × 7 = 56  
5P4= 5 × 4 × 3 × 2 = 120

**10. Number of Combinations of n distinct things taking r at a time**  
Number of combinations of n distinct things taking r at a time ( nCr) can be given by

**nCr = n! / [(n-r)! \* r!]**

**SOLVED EXAMPLES**

**1.From a group of 7 men and 6 women, five persons are to be selected to form a committee so that at least 3 men are there on the committee. In how many ways can it be done?**  
**Solution:**

We may have (3 men and 2 women) or (4 men and 1 woman) or (5 men only).  
 Required number of ways= (7C3 x 6C2) + (7C4 x 6C1) + (7C5)  
=  756.   
  
**2.In how many different ways can the letters of the word 'LEADING' be arranged in such a way that the vowels always come together?**   
**Solution:**

The word 'LEADING' has 7 different letters.  
When the vowels EAI are always together, they can be supposed to form one letter.  
Then, we have to arrange the letters LNDG (EAI).  
Now, 5 (4 + 1 = 5) letters can be arranged in 5! = 120 ways.  
The vowels (EAI) can be arranged among themselves in 3!

= 6 ways.  
Required number of ways = (120 x 6) = 720.

**3.In how many ways can a group of 5 men and 2 women be made out of a total of 7 men and 3 women?  
Solution:**

Required number of ways = (7C5 x 3C2) = (7C2 x 3C1) = 63  
  
**4.How many 3-digit numbers can be formed from the digits 2, 3, 5, 6, 7 and 9, which are divisible by 5 and none of the digits is repeated?  
Solution:**

Since each desired number is divisible by 5, so we must have 5 at the unit place. So, there is 1 way of doing it.  
The tens place can now be filled by any of the remaining 5 digits (2, 3, 6, 7, 9). So, there are 5 ways of filling the tens place.

The hundreds place can now be filled by any of the remaining 4 digits. So, there are 4 ways of filling it.  
Required number of numbers = (1 x 5 x 4) = 20.