Multinomial Theorem (For positive integral index).

If n is positive integer and $a_1, a_2, a_3, \ldots. a_n \in C$ then

$$(a_1 + a_2 + a_3 + \ldots + a_m)^n = \sum \frac{n!}{n_1! n_2! n_3! \ldots n_m!} a_1^{n_1} a_2^{n_2} \ldots a_m^{n_m}$$

Where $n_1, n_2, n_3, \ldots.. n_m$ are all non-negative integers subject to the condition,

$n_1 + n_2 + n_3 + \ldots.. n_m = n$.

(1) The coefficient of $a_1^{n_1}.a_2^{n_2} \ldots.. a_m^{n_m}$ in the expansion of $(a_1 + a_2 + a_3 + \ldots. a_m)^n$ is $\dfrac{n!}{n_1! n_2! n_3! \ldots. n_m!}$

(2) The greatest coefficient in the expansion of $(a_1 + a_2 + a_3 + \ldots. a_m)^n$ is $\dfrac{n!}{(q!)^{m-r}[(q+1)!]^r}$

Where q is the quotient and r is the remainder when n is divided by m.

(3) If n is +ve integer and $a_1, a_2, \ldots.. a_m \in C$, $a_1^{n_1} . a_2^{n_2} \ldots\ldots\ldots a_m^{n_m}$ then coefficient of x^r in the expansion of $(a_1 + a_2 x + \ldots.. a_m x^{m-1})^n$ is $\sum \dfrac{n!}{n_1! n_2! n_3! \ldots.. n_m!}$

Where $n_1, n_2 \ldots.. n_m$ are all non-negative integers subject to the condition: $n_1 + n_2 + \ldots.. n_m = n$ and $n_2 + 2n_3 + 3n_4 + \ldots. + (m-1)n_m = r$.

(4) The number of distinct or dissimilar terms in the multinomial expansion $(a_1 + a_2 + a_3 + \ldots. a_m)^n$ is ${}^{n+m-1}C_{m-1}$.