# TURBO

*Created by students, for students*

# Binomial Theorem

Class 11 Mathematics • Complete Formula Sheet

| Sr. | Concept | Formulas | Other Information |
|---|---|---|---|
| 1 | Binomial Theorem for any positive integer | $(a+b)^n = \binom{n}{0}a^n + \binom{n}{1}a^{n-1}b + \binom{n}{2}a^{n-2}b^2 + ... + \binom{n}{n-1}ab^{n-1} + \binom{n}{n}b^n$<br>Or: $(a+b)^n = \sum_{k=0}^{n}\binom{n}{k}a^{n-k}b^k$ | The expansion of a binomial for any positive integral $n$<br>$\binom{n}{k} = \frac{n!}{k!(n-k)!}$ |
| 2 | Binomial Expansion using $\binom{n}{r}$ | $(a+b)^n = {}^nC_0a^n + {}^nC_1a^{n-1}b + {}^nC_2a^{n-2}b^2 + ... + {}^nC_na^0b^n$ | ${}^nC_r = \binom{n}{r} = \frac{n!}{r!(n-r)!}$ |
| 3 | Expansion of $(x-y)^n$ | Taking $a=x$ and $b=-y$ in binomial expansion:<br>$(x-y)^n = \sum_{k=0}^{n}\binom{n}{k}x^{n-k}(-y)^k$<br>$= {}^nC_0x^n - {}^nC_1x^{n-1}y + {}^nC_2x^{n-2}y^2 - {}^nC_3x^{n-3}y^3 + ... + (-1)^n{}^nC_ny^n$ | Signs alternate: positive, negative, positive, negative, ...<br>$(-1)^k$ determines the sign |
| 4 | General Term ($(r+1)^{th}$ term) | The $(r+1)^{th}$ term (denoted by $T_{r+1}$) is:<br>$T_{r+1} = {}^nC_ra^{n-r}b^r$<br>Or: $T_{r+1} = \binom{n}{r}a^{n-r}b^r$ | This is the general term of expansion $(a+b)^n$<br>For $(x-y)^n$: $T_{r+1} = (-1)^r{}^nC_rx^{n-r}y^r$ |
| 5 | Middle Term | **If $n$ is even:**<br>Middle term = $\left(\frac{n}{2}+1\right)^{th}$ term<br>**If $n$ is odd:**<br>Two middle terms: $\left(\frac{n+1}{2}\right)^{th}$ and $\left(\frac{n+3}{2}\right)^{th}$ terms | For even $n$: one middle term<br>For odd $n$: two middle terms |
| 6 | Properties of Binomial Coefficients | (i) ${}^nC_0 + {}^nC_1 + {}^nC_2 + ... + {}^nC_n = 2^n$<br>(ii) ${}^nC_0 - {}^nC_1 + {}^nC_2 - {}^nC_3 + ... = 0$<br>(iii) ${}^nC_0 + {}^nC_2 + {}^nC_4 + ... = 2^{n-1}$ (even terms)<br>(iv) ${}^nC_1 + {}^nC_3 + {}^nC_5 + ... = 2^{n-1}$ (odd terms)<br>(v) ${}^nC_r = {}^nC_{n-r}$ | Put $a=b=1$ in $(a+b)^n$ for property (i)<br>Put $a=1, b=-1$ for property (ii) |