

Class 11 Maths: Complete Formula Sheet

All 14 NCERT chapters · CBSE syllabus 2026-27 · NCERT textbook (Reprint 2026-27)

How to use this sheet. Plain boxes cover the topics tested in the annual exam. Boxes marked ★ **Formative only** cover topics that are still in the CBSE 2026-27 syllabus but are **assessed only formatively** (class activities, not the annual exam). They are included so the sheet is complete, and because many of them come back in Class 12 and JEE. In the trigonometry formulas, n stands for any integer ($n \in \mathbb{Z}$).

- | | |
|--|---------------------------------|
| 1. Sets | 8. Sequences and Series |
| 2. Relations and Functions | 9. Straight Lines |
| 3. Trigonometric Functions | 10. Conic Sections |
| 4. Complex Numbers and Quadratic Equations | 11. Introduction to 3D Geometry |
| 5. Linear Inequalities | 12. Limits and Derivatives |
| 6. Permutations and Combinations | 13. Statistics |
| 7. Binomial Theorem | 14. Probability |

1 Sets

BASICS

- Empty set: $\varnothing = \{ \}$; $n(A)$ = number of elements of a finite set A
- $A \subset B$ if every element of A is in B
- $A = B \iff A \subset B$ and $B \subset A$
- $\varnothing \subset A$ and $A \subset A$ for every set A
- $\mathbb{N} \subset \mathbb{Z} \subset \mathbb{Q} \subset \mathbb{R}$, $\mathbb{T} \subset \mathbb{R}$ (irrationals), $\mathbb{Q} \cap \mathbb{T} = \varnothing$

INTERVALS (SUBSETS OF $\mathbb{R}$, $a < b$)

- Open: $(a, b) = \{x : a < x < b\}$
- Closed: $[a, b] = \{x : a \leq x \leq b\}$
- $[a, b) = \{x : a \leq x < b\}$, $(a, b] = \{x : a < x \leq b\}$
- Length of each interval = $b - a$

OPERATIONS

- $A \cup B = \{x : x \in A \text{ or } x \in B\}$
- $A \cap B = \{x : x \in A \text{ and } x \in B\}$; disjoint if $A \cap B = \varnothing$
- $A - B = \{x : x \in A, x \notin B\} = A \cap B'$
- Complement: $A' = U - A = \{x \in U : x \notin A\}$
- $A - B$, $A \cap B$, $B - A$ are pairwise disjoint and their union is $A \cup B$

LAWS OF UNION AND INTERSECTION

- Commutative: $A \cup B = B \cup A$, $A \cap B = B \cap A$
- Associative: $(A \cup B) \cup C = A \cup (B \cup C)$, same for $\cap$
- Identity: $A \cup \varnothing = A$, $A \cap U = A$
- Idempotent: $A \cup A = A$, $A \cap A = A$
- Law of U : $U \cup A = U$; $\varnothing \cap A = \varnothing$
- Distributive: $A \cap (B \cup C) = (A \cap B) \cup (A \cap C)$,
 $A \cup (B \cap C) = (A \cup B) \cap (A \cup C)$

COMPLEMENT LAWS

- $A \cup A' = U$, $A \cap A' = \varnothing$
- De Morgan: $(A \cup B)' = A' \cap B'$, $(A \cap B)' = A' \cup B'$
- Double complement: $(A')' = A$
- $\varnothing' = U$, $U' = \varnothing$

★ FORMATIVE ONLY: COUNTING WITH UNION AND INTERSECTION

- $n(A \cup B) = n(A) + n(B) - n(A \cap B)$
- If $A \cap B = \varnothing$: $n(A \cup B) = n(A) + n(B)$
- $n(A \cup B \cup C) = n(A) + n(B) + n(C) - n(A \cap B) - n(B \cap C) - n(A \cap C) + n(A \cap B \cap C)$



2 Relations and Functions

CARTESIAN PRODUCT

- $(a, b) = (x, y) \iff a = x \text{ and } b = y$
- $A \times B = \{(a, b) : a \in A, b \in B\}$
- $n(A) = p, n(B) = q \Rightarrow n(A \times B) = pq$
- $A \times \varnothing = \varnothing$; in general $A \times B \neq B \times A$
- $\mathbb{R} \times \mathbb{R} = \{(x, y) : x, y \in \mathbb{R}\}$; $\mathbb{R} \times \mathbb{R} \times \mathbb{R} = \{(x, y, z) : x, y, z \in \mathbb{R}\}$

RELATIONS

- A relation R from A to B is a subset of $A \times B$
- Domain = set of first elements; range = set of second elements; codomain = B
- Range $\subseteq$ codomain
- Number of relations from A to $B = 2^{pq}$

FUNCTIONS

- $f : A \rightarrow B$ is a relation in which **every** $x \in A$ has **exactly one** image $f(x) \in B$
- A = domain, B = codomain, range = set of images
- Real function: domain and range are subsets of $\mathbb{R}$

ALGEBRA OF REAL FUNCTIONS ($x \in X$)

- $(f \pm g)(x) = f(x) \pm g(x)$
- $(fg)(x) = f(x)g(x)$; $(kf)(x) = kf(x)$
- $\left(\frac{f}{g}\right)(x) = \frac{f(x)}{g(x)}, g(x) \neq 0$

STANDARD REAL FUNCTIONS

Function	Rule	Domain	Range
Identity	$f(x) = x$	$\mathbb{R}$	$\mathbb{R}$
Constant	$f(x) = c$	$\mathbb{R}$	$\{c\}$
Polynomial	$a_0 + a_1x + \dots + a_nx^n$	$\mathbb{R}$	depends on f
Rational	$\frac{f(x)}{g(x)}, f, g \text{ polynomials}$	$\{x : g(x) \neq 0\}$	depends on f, g
Modulus	$ x = \begin{cases} x, & x \geq 0 \\ -x, & x < 0 \end{cases}$	$\mathbb{R}$	$[0, \infty)$
Signum	$\begin{cases} 1, & x > 0 \\ 0, & x = 0 \\ -1, & x < 0 \end{cases} \left(= \frac{ x }{x}, x \neq 0 \right)$	$\mathbb{R}$	$\{-1, 0, 1\}$
Greatest integer	$[x] = \text{greatest integer} \leq x$	$\mathbb{R}$	$\mathbb{Z}$
Exponential	$a^x, a > 0, a \neq 1$	$\mathbb{R}$	$(0, \infty)$
Logarithmic	$\log_a x, a > 0, a \neq 1$	$(0, \infty)$	$\mathbb{R}$

Examples: $[2.7] = 2, [-2.7] = -3, [5] = 5$.

LAWS OF LOGARITHMS ($m, n > 0$)

- $\log_a(mn) = \log_a m + \log_a n$
- $\log_a \frac{m}{n} = \log_a m - \log_a n$
- $\log_a m^k = k \log_a m$
- $\log_a x = \frac{\log_b x}{\log_b a}$; $\log_a a = 1, \log_a 1 = 0$
- $a^{\log_a x} = x \text{ for } x > 0$

★ FORMATIVE ONLY: COMPOSITION

- $(f \circ g)(x) = f(g(x))$, defined when the range of g lies in the domain of f
- In general $f \circ g \neq g \circ f$



3 Trigonometric Functions

ANGLE MEASURE

- Arc length: $l = r\theta$ (θ in radians)
- Radian measure $= \frac{\pi}{180} \times \text{degree measure}$
- Degree measure $= \frac{180}{\pi} \times \text{radian measure}$
- $1 \text{ rad} \approx 57^\circ 16'$; $1^\circ \approx 0.01746 \text{ rad}$; $\pi \text{ rad} = 180^\circ$

Degree	30°	45°	60°	90°	180°	270°	360°
Radian	$\frac{\pi}{6}$	$\frac{\pi}{4}$	$\frac{\pi}{3}$	$\frac{\pi}{2}$	π	$\frac{3\pi}{2}$	2π

DEFINITIONS AND IDENTITIES

- $\csc x = \frac{1}{\sin x}$, $\sec x = \frac{1}{\cos x}$, $\cot x = \frac{1}{\tan x}$
- $\tan x = \frac{\sin x}{\cos x}$, $\cot x = \frac{\cos x}{\sin x}$
- $\sin^2 x + \cos^2 x = 1$
- $1 + \tan^2 x = \sec^2 x$
- $1 + \cot^2 x = \csc^2 x$

NCERT writes $\csc x$ as $\operatorname{cosec} x$.

VALUES OF STANDARD ANGLES

	0	$\frac{\pi}{6}$	$\frac{\pi}{4}$	$\frac{\pi}{3}$	$\frac{\pi}{2}$	π	$\frac{3\pi}{2}$	2π
sin	0	$\frac{1}{2}$	$\frac{1}{\sqrt{2}}$	$\frac{\sqrt{3}}{2}$	1	0	-1	0
cos	1	$\frac{\sqrt{3}}{2}$	$\frac{1}{\sqrt{2}}$	$\frac{1}{2}$	0	-1	0	1
tan	0	$\frac{1}{\sqrt{3}}$	1	$\sqrt{3}$	not defined	0	not defined	0

SIGNS BY QUADRANT

	I	II	III	IV
sin, cosec	+	+	-	-
cos, sec	+	-	-	+
tan, cot	+	-	+	-

Memory aid: All, Sin, Tan, Cos are positive in quadrants I, II, III, IV.

DOMAIN AND RANGE

Function	Domain	Range
sin, cos	$\mathbb{R}$	$[-1, 1]$
tan, sec	$\mathbb{R} - \{(2n+1)\frac{\pi}{2}\}$	tan: $\mathbb{R}$; sec: $\mathbb{R} - (-1, 1)$
cot, cosec	$\mathbb{R} - \{n\pi\}$	cot: $\mathbb{R}$; cosec: $\mathbb{R} - (-1, 1)$

$$\sin x = 0 \iff x = n\pi; \cos x = 0 \iff x = (2n+1)\frac{\pi}{2}.$$

Period: sin, cos, sec, cosec = 2π ; tan, cot = π .

ALLIED ANGLES

	$-x$	$\frac{\pi}{2} - x$	$\frac{\pi}{2} + x$	$\pi - x$	$\pi + x$	$2\pi - x$	$2\pi + x$
sin	$-\sin x$	$\cos x$	$\cos x$	$\sin x$	$-\sin x$	$-\sin x$	$\sin x$
cos	$\cos x$	$\sin x$	$-\sin x$	$-\cos x$	$-\cos x$	$\cos x$	$\cos x$
tan	$-\tan x$	$\cot x$	$-\cot x$	$-\tan x$	$\tan x$	$-\tan x$	$\tan x$

SUM AND DIFFERENCE

- $\sin(x \pm y) = \sin x \cos y \pm \cos x \sin y$
- $\cos(x + y) = \cos x \cos y - \sin x \sin y$
- $\cos(x - y) = \cos x \cos y + \sin x \sin y$
- $\tan(x \pm y) = \frac{\tan x \pm \tan y}{1 \mp \tan x \tan y}$
- $\cot(x \pm y) = \frac{\cot x \cot y \pm 1}{\cot y \pm \cot x}$

tan formulas need none of $x, y, x \pm y$ to be an odd multiple of $\frac{\pi}{2}$; cot formulas need none to be a multiple of π .

MULTIPLE ANGLES

- $\sin 2x = 2 \sin x \cos x = \frac{2 \tan x}{1 + \tan^2 x}$
- $\cos 2x = \cos^2 x - \sin^2 x = 2 \cos^2 x - 1$
- $\cos 2x = 1 - 2 \sin^2 x = \frac{1 - \tan^2 x}{1 + \tan^2 x}$
- $\tan 2x = \frac{2 \tan x}{1 - \tan^2 x}$
- $\sin 3x = 3 \sin x - 4 \sin^3 x$
- $\cos 3x = 4 \cos^3 x - 3 \cos x$
- $\tan 3x = \frac{3 \tan x - \tan^3 x}{1 - 3 \tan^2 x}$
- $2 \sin^2 x = 1 - \cos 2x$, $2 \cos^2 x = 1 + \cos 2x$



SUM TO PRODUCT

- $\cos x + \cos y = 2 \cos \frac{x+y}{2} \cos \frac{x-y}{2}$
- $\cos x - \cos y = -2 \sin \frac{x+y}{2} \sin \frac{x-y}{2}$
- $\sin x + \sin y = 2 \sin \frac{x+y}{2} \cos \frac{x-y}{2}$
- $\sin x - \sin y = 2 \cos \frac{x+y}{2} \sin \frac{x-y}{2}$

PRODUCT TO SUM

- $2 \cos x \cos y = \cos(x+y) + \cos(x-y)$
- $-2 \sin x \sin y = \cos(x+y) - \cos(x-y)$
- $2 \sin x \cos y = \sin(x+y) + \sin(x-y)$
- $2 \cos x \sin y = \sin(x+y) - \sin(x-y)$

★ FORMATIVE ONLY: GENERAL SOLUTIONS ($n \in \mathbb{Z}$)

- $\sin x = 0 \Rightarrow x = n\pi$; $\cos x = 0 \Rightarrow x = (2n+1)\frac{\pi}{2}$; $\tan x = 0 \Rightarrow x = n\pi$
- $\sin x = \sin y \Rightarrow x = n\pi + (-1)^n y$; $\cos x = \cos y \Rightarrow x = 2n\pi \pm y$; $\tan x = \tan y \Rightarrow x = n\pi + y$

4 Complex Numbers and Quadratic Equations**BASICS**

- $i = \sqrt{-1}$, $i^2 = -1$
- $z = a + ib$: $\text{Re}(z) = a$, $\text{Im}(z) = b$
- $a + ib = c + id \iff a = c \text{ and } b = d$
- Powers of i ($k \in \mathbb{Z}$): $i^{4k} = 1$, $i^{4k+1} = i$, $i^{4k+2} = -1$, $i^{4k+3} = -i$
- $\sqrt{-a} = i\sqrt{a}$ for $a > 0$
- $\sqrt{a}\sqrt{b} = \sqrt{ab}$ is **false** when a, b are both negative

ALGEBRA ($z_1 = a + ib$, $z_2 = c + id$)

- $z_1 \pm z_2 = (a \pm c) + i(b \pm d)$
- $z_1 z_2 = (ac - bd) + i(ad + bc)$
- $\frac{z_1}{z_2} = \frac{(ac + bd) + i(bc - ad)}{c^2 + d^2}$, $z_2 \neq 0$
- Inverse: $z^{-1} = \frac{1}{a + ib} = \frac{a}{a^2 + b^2} - i \frac{b}{a^2 + b^2} = \frac{\bar{z}}{|z|^2}$

IDENTITIES (ANY COMPLEX z_1, z_2)

- $(z_1 \pm z_2)^2 = z_1^2 \pm 2z_1 z_2 + z_2^2$
- $(z_1 \pm z_2)^3 = z_1^3 \pm 3z_1^2 z_2 + 3z_1 z_2^2 \pm z_2^3$
- $z_1^2 - z_2^2 = (z_1 + z_2)(z_1 - z_2)$

MODULUS AND CONJUGATE

- $|z| = \sqrt{a^2 + b^2}$, $\bar{z} = a - ib$
- $z\bar{z} = |z|^2$
- $|z_1 z_2| = |z_1| |z_2|$, $\left| \frac{z_1}{z_2} \right| = \frac{|z_1|}{|z_2|}$ ($z_2 \neq 0$)
- $\overline{z_1 z_2} = \bar{z}_1 \bar{z}_2$, $\overline{z_1 \pm z_2} = \bar{z}_1 \pm \bar{z}_2$, $\overline{\left(\frac{z_1}{z_2} \right)} = \frac{\bar{z}_1}{\bar{z}_2}$

ARGAND PLANE

- $z = x + iy$ is the point $P(x, y)$; x-axis = real axis, y-axis = imaginary axis
- $|z| = OP$, the distance of P from the origin
- $\bar{z} = x - iy$ is the point $(x, -y)$, the mirror image of P in the real axis

★ FORMATIVE ONLY: POLAR FORM AND QUADRATICS

- $z = r(\cos \theta + i \sin \theta)$, where $r = |z| = \sqrt{x^2 + y^2}$, $\theta = \arg z$
- Principal argument: $-\pi < \theta \leq \pi$
- $ax^2 + bx + c = 0$ with $D = b^2 - 4ac < 0$: $x = \frac{-b \pm i\sqrt{4ac - b^2}}{2a}$
- Fundamental theorem of algebra: a polynomial equation of degree n has n roots



5 Linear Inequalities

RULES FOR SOLVING

- The same number may be added to or subtracted from both sides
- Multiplying or dividing both sides by a **positive** number keeps the sign
- Multiplying or dividing both sides by a **negative** number **reverses** the sign: $a < b \Rightarrow -a > -b$
- Solutions = all values of x that make the inequality true

NUMBER LINE AND INTERVAL FORM

- $x < a$ or $x > a$: open (hollow) circle at a
- $x \leq a$ or $x \geq a$: dark (filled) circle at a
- $x < a \iff x \in (-\infty, a)$; $x \leq a \iff x \in (-\infty, a]$
- $x > a \iff x \in (a, \infty)$; $x \geq a \iff x \in [a, \infty)$
- $a < x \leq b \iff x \in (a, b]$

★ FORMATIVE ONLY: TWO VARIABLES (GRAPHICAL)

- $ax + by < c$ (or $>$): draw $ax + by = c$ as a **dotted** line; for $\leq$ or $\geq$ draw it as a **solid** line
- Test a point not on the line (e.g. $(0, 0)$); shade the half-plane where the inequality holds
- For a system, the solution region is the common (overlapping) shaded region

6 Permutations and Combinations

COUNTING AND FACTORIALS

- Fundamental principle: if one event can occur in m ways and then another in n ways, both occur in that order in $m \times n$ ways
- $n! = 1 \times 2 \times 3 \times \dots \times n$
- $n! = n \times (n-1)!$; $0! = 1$

PERMUTATIONS (ARRANGEMENTS)

- ${}^nP_r = \frac{n!}{(n-r)!}$, $0 \leq r \leq n$
- ${}^nP_n = n!$, ${}^nP_0 = 1$
- With repetition allowed: n^r
- n objects with p_1 alike of one kind, p_2 of another, ..., p_k of a k th kind: $\frac{n!}{p_1! p_2! \dots p_k!}$

COMBINATIONS (SELECTIONS)

- ${}^nC_r = \frac{n!}{r!(n-r)!}$, $0 \leq r \leq n$
- ${}^nP_r = {}^nC_r \times r!$
- ${}^nC_0 = {}^nC_n = 1$, ${}^nC_1 = n$

PROPERTIES OF ${}^nC_r$

- ${}^nC_r = {}^nC_{n-r}$
- ${}^nC_a = {}^nC_b \Rightarrow a = b$ or $a + b = n$
- ${}^nC_r + {}^nC_{r-1} = {}^{n+1}C_r$

7 Binomial Theorem

BINOMIAL THEOREM (POSITIVE INTEGER n)

$$(a+b)^n = {}^nC_0 a^n + {}^nC_1 a^{n-1}b + {}^nC_2 a^{n-2}b^2 + \dots + {}^nC_{n-1} a b^{n-1} + {}^nC_n b^n = \sum_{k=0}^n {}^nC_k a^{n-k} b^k$$

- There are $n+1$ terms; in every term the powers of a and b add up to n
- The coefficients ${}^nC_k$ are the binomial coefficients



SPECIAL CASES

- $(a - b)^n = \sum_{k=0}^n (-1)^k {}^nC_k a^{n-k} b^k$
- $(1 + x)^n = {}^nC_0 + {}^nC_1 x + {}^nC_2 x^2 + \dots + {}^nC_n x^n$
- $(1 - x)^n = {}^nC_0 - {}^nC_1 x + {}^nC_2 x^2 - \dots + (-1)^n {}^nC_n x^n$
- ${}^nC_0 + {}^nC_1 + \dots + {}^nC_n = 2^n$

PASCAL'S TRIANGLE

$n = 0$	1
$n = 1$	1 1
$n = 2$	1 2 1
$n = 3$	1 3 3 1
$n = 4$	1 4 6 4 1
$n = 5$	1 5 10 10 5 1

Each entry is the sum of the two entries above it (that is ${}^nC_r + {}^nC_{r-1} = {}^{n+1}C_r$).

★ FORMATIVE ONLY: GENERAL AND MIDDLE TERMS

- General term of $(a + b)^n$: $T_{r+1} = {}^nC_r a^{n-r} b^r$
- n even: one middle term, the $(\frac{n}{2} + 1)$ th term
- n odd: two middle terms, the $(\frac{n+1}{2})$ th and $(\frac{n+3}{2})$ th terms

8 Sequences and Series**A.P. (RECALL FROM CLASS 10) AND A.M.**

- n th term: $a_n = a + (n - 1)d$
- $S_n = \frac{n}{2} [2a + (n - 1)d] = \frac{n}{2} (a + l)$, l = last term
- A.M. of a and b : $A = \frac{a+b}{2}$
- n A.M.s between a and b : common difference $d = \frac{b-a}{n+1}$

GEOMETRIC PROGRESSION

- $a, ar, ar^2, \dots$ with common ratio $r = \frac{a_{k+1}}{a_k}$
- n th term: $a_n = ar^{n-1}$
- $S_n = \frac{a(r^n - 1)}{r - 1} = \frac{a(1 - r^n)}{1 - r}$, $r \neq 1$
- If $r = 1$: $S_n = na$
- Infinite G.P., $|r| < 1$: $S_\infty = \frac{a}{1 - r}$

GEOMETRIC MEAN

- G.M. of positive a, b : $G = \sqrt{ab}$ (so a, G, b is a G.P.)
- n G.M.s between a and b : $r = \left(\frac{b}{a}\right)^{\frac{1}{n+1}}$, and $G_k = ar^k$
- Three numbers in A.P.: $a - d, a, a + d$. In G.P.: $\frac{a}{r}, a, ar$

A.M. AND G.M. RELATION

- For positive a, b : $A \geq G$, i.e. $\frac{a+b}{2} \geq \sqrt{ab}$
- $A - G = \frac{(\sqrt{a} - \sqrt{b})^2}{2}$; equality only when $a = b$
- Numbers with A.M. A and G.M. G are the roots of $x^2 - 2Ax + G^2 = 0$, i.e. $A \pm \sqrt{A^2 - G^2}$

★ FORMATIVE ONLY: SPECIAL SUMS

$$\sum_{k=1}^n k = \frac{n(n+1)}{2} \quad \sum_{k=1}^n k^2 = \frac{n(n+1)(2n+1)}{6} \quad \sum_{k=1}^n k^3 = \left[\frac{n(n+1)}{2} \right]^2$$



9 Straight Lines

RECALL: COORDINATE GEOMETRY

- Distance: $PQ = \sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2}$
- Section formula (ratio $m : n$, internal): $\left(\frac{mx_2 + nx_1}{m + n}, \frac{my_2 + ny_1}{m + n}\right)$; mid-point: $\left(\frac{x_1 + x_2}{2}, \frac{y_1 + y_2}{2}\right)$
- Area of triangle: $\frac{1}{2} |x_1(y_2 - y_3) + x_2(y_3 - y_1) + x_3(y_1 - y_2)|$; the points are collinear if this is 0

SLOPE

- $m = \tan \alpha$, $\alpha \neq 90^\circ$ (α = inclination with the positive x-axis)
- $m = \frac{y_2 - y_1}{x_2 - x_1}$, $x_1 \neq x_2$
- Horizontal line: $m = 0$; vertical line: slope not defined
- Parallel: $m_1 = m_2$; perpendicular: $m_1 m_2 = -1$
- A, B, C collinear $\iff$ slope AB = slope BC

ANGLE BETWEEN TWO LINES

$$\tan \theta = \left| \frac{m_2 - m_1}{1 + m_1 m_2} \right|, \quad 1 + m_1 m_2 \neq 0$$

This gives the acute angle θ ; the obtuse angle is $180^\circ - \theta$.

FORMS OF THE EQUATION OF A LINE

Form	Equation
Horizontal, distance a from x-axis	$y = a$ or $y = -a$
Vertical, distance b from y-axis	$x = b$ or $x = -b$
Point-slope, through (x_0, y_0)	$y - y_0 = m(x - x_0)$
Two-point	$y - y_1 = \frac{y_2 - y_1}{x_2 - x_1}(x - x_1)$
Slope-intercept (y-intercept c)	$y = mx + c$
Slope m , x-intercept d	$y = m(x - d)$
Intercept form	$\frac{x}{a} + \frac{y}{b} = 1$

DISTANCES

- Point (x_1, y_1) to line $Ax + By + C = 0$:

$$d = \frac{|Ax_1 + By_1 + C|}{\sqrt{A^2 + B^2}}$$
- Between parallel lines $Ax + By + C_1 = 0$ and $Ax + By + C_2 = 0$:

$$d = \frac{|C_1 - C_2|}{\sqrt{A^2 + B^2}}$$

★ FORMATIVE ONLY: GENERAL AND NORMAL FORM

- General equation: $Ax + By + C = 0$ (A, B not both 0)
- Slope = $-\frac{A}{B}$ ($B \neq 0$); x-intercept = $-\frac{C}{A}$ ($A \neq 0$); y-intercept = $-\frac{C}{B}$ ($B \neq 0$)
- Parallel to it: $Ax + By + k = 0$; perpendicular to it: $Bx - Ay + k = 0$
- Normal form: $x \cos \omega + y \sin \omega = p$ (p = perpendicular distance from origin, ω = angle of the perpendicular with the positive x-axis)



10 Conic Sections

SECTIONS OF A CONE

α = semi-vertical angle of the cone, β = angle between the cutting plane and the axis.

- Plane not through vertex: $\beta = 90^\circ$: circle; $\alpha < \beta < 90^\circ$: ellipse; $\beta = \alpha$: parabola; $0 \leq \beta < \alpha$: hyperbola
- Plane through vertex (degenerate): $\alpha < \beta \leq 90^\circ$: a point; $\beta = \alpha$: a straight line; $0 \leq \beta < \alpha$: a pair of intersecting lines

CIRCLE

- Centre (h, k) , radius r : $(x - h)^2 + (y - k)^2 = r^2$
- Centre at origin: $x^2 + y^2 = r^2$
- $x^2 + y^2 + 2gx + 2fy + c = 0$: centre $(-g, -f)$, radius $\sqrt{g^2 + f^2 - c}$

PARABOLA (VERTEX AT ORIGIN, $a > 0$)

Equation	$y^2 = 4ax$	$y^2 = -4ax$	$x^2 = 4ay$	$x^2 = -4ay$
Opens	right	left	upward	downward
Focus	$(a, 0)$	$(-a, 0)$	$(0, a)$	$(0, -a)$
Directrix	$x = -a$	$x = a$	$y = -a$	$y = a$
Axis	x-axis	x-axis	y-axis	y-axis
Latus rectum	length $4a$; for $y^2 = 4ax$ its ends are $(a, \pm 2a)$			

Definition: every point is equidistant from the focus and the directrix.

ELLIPSE AND HYPERBOLA

	Ellipse	Hyperbola
Definition	sum of distances from foci = $2a$	difference of distances from foci = $2a$
Foci on x-axis	$\frac{x^2}{a^2} + \frac{y^2}{b^2} = 1$ ($a > b$)	$\frac{x^2}{a^2} - \frac{y^2}{b^2} = 1$
Foci on y-axis	$\frac{x^2}{b^2} + \frac{y^2}{a^2} = 1$ ($a > b$)	$\frac{y^2}{a^2} - \frac{x^2}{b^2} = 1$
Relation	$c^2 = a^2 - b^2$	$c^2 = a^2 + b^2$
Foci	$(\pm c, 0)$ or $(0, \pm c)$	$(\pm c, 0)$ or $(0, \pm c)$
Vertices	$(\pm a, 0)$ or $(0, \pm a)$	$(\pm a, 0)$ or $(0, \pm a)$
Axes	major = $2a$, minor = $2b$	transverse = $2a$, conjugate = $2b$
Eccentricity $e = \frac{c}{a}$	$0 < e < 1$	$e > 1$
Latus rectum	$\frac{2b^2}{a}$	$\frac{2b^2}{a}$

In both curves, a is always the distance from the centre to a vertex. Ellipse: if $e \rightarrow 0$, it approaches a circle.



11 Introduction to Three Dimensional Geometry

AXES, PLANES AND POINTS

- Three mutually perpendicular axes; coordinate planes XY, YZ, ZX divide space into 8 octants
- In $P(x, y, z)$: x, y, z are the distances from the YZ, ZX and XY planes
- On x-axis $(x, 0, 0)$; y-axis $(0, y, 0)$; z-axis $(0, 0, z)$
- In XY-plane $(x, y, 0)$; YZ-plane $(0, y, z)$; ZX-plane $(x, 0, z)$

SIGNS IN THE OCTANTS

Octant	I	II	III	IV	V	VI	VII	VIII
x	+	-	-	+	+	-	-	+
y	+	+	-	-	+	+	-	-
z	+	+	+	+	-	-	-	-

DISTANCE FORMULA

$$PQ = \sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2 + (z_2 - z_1)^2}$$

- Distance from origin: $OP = \sqrt{x^2 + y^2 + z^2}$

★ FORMATIVE ONLY: SECTION FORMULA

- Internal, ratio $m : n$:

$$\left(\frac{mx_2 + nx_1}{m + n}, \frac{my_2 + ny_1}{m + n}, \frac{mz_2 + nz_1}{m + n} \right)$$
- External:
$$\left(\frac{mx_2 - nx_1}{m - n}, \frac{my_2 - ny_1}{m - n}, \frac{mz_2 - nz_1}{m - n} \right)$$
- Mid-point:
$$\left(\frac{x_1 + x_2}{2}, \frac{y_1 + y_2}{2}, \frac{z_1 + z_2}{2} \right)$$
- Centroid:
$$\left(\frac{x_1 + x_2 + x_3}{3}, \frac{y_1 + y_2 + y_3}{3}, \frac{z_1 + z_2 + z_3}{3} \right)$$

12 Limits and Derivatives

LIMITS: BASICS

- $\lim_{x \rightarrow a} f(x)$ exists $\iff$ LHL = $\lim_{x \rightarrow a^-} f(x)$ equals RHL = $\lim_{x \rightarrow a^+} f(x)$
- $\lim_{x \rightarrow a} f(x)$ and $f(a)$ may differ (one may exist without the other)
- Polynomial: $\lim_{x \rightarrow a} f(x) = f(a)$
- Rational: $\lim_{x \rightarrow a} \frac{g(x)}{h(x)} = \frac{g(a)}{h(a)}$ if $h(a) \neq 0$

ALGEBRA OF LIMITS

- $\lim[f(x) \pm g(x)] = \lim f(x) \pm \lim g(x)$
- $\lim[f(x) g(x)] = \lim f(x) \cdot \lim g(x)$
- $\lim \frac{f(x)}{g(x)} = \frac{\lim f(x)}{\lim g(x)}$, if $\lim g(x) \neq 0$
- $\lim[k f(x)] = k \lim f(x)$
- Sandwich theorem: if $f \leq g \leq h$ and $\lim f = \lim h = l$, then $\lim g = l$

STANDARD LIMITS

$$\lim_{x \rightarrow a} \frac{x^n - a^n}{x - a} = n a^{n-1} \quad \lim_{x \rightarrow 0} \frac{\sin x}{x} = 1 \quad \lim_{x \rightarrow 0} \frac{1 - \cos x}{x} = 0 \quad \lim_{x \rightarrow 0} \frac{\tan x}{x} = 1$$

$$\lim_{x \rightarrow 0} \frac{e^x - 1}{x} = 1 \quad \lim_{x \rightarrow 0} \frac{\log_e(1 + x)}{x} = 1 \quad \lim_{x \rightarrow 0} \frac{a^x - 1}{x} = \log_e a$$

x in radians. Useful: $\lim_{x \rightarrow 0} \frac{\sin ax}{bx} = \frac{a}{b}$. The exponential and logarithmic limits are listed in the CBSE 2026-27 syllabus.



DERIVATIVE: DEFINITION

- At a point: $f'(a) = \lim_{h \rightarrow 0} \frac{f(a+h) - f(a)}{h}$

- First principle:

$$\frac{d}{dx} f(x) = f'(x) = \lim_{h \rightarrow 0} \frac{f(x+h) - f(x)}{h}$$

- $f'(a)$ = slope of the tangent to $y = f(x)$ at $(a, f(a))$ = rate of change of f at a

RULES OF DIFFERENTIATION

- $(u \pm v)' = u' \pm v'$
- Product: $(uv)' = u'v + uv'$
- Quotient: $\left(\frac{u}{v}\right)' = \frac{u'v - uv'}{v^2}$, $v \neq 0$
- $(ku)' = k u'$; derivative of a constant = 0

STANDARD DERIVATIVES

$f(x)$	x^n	c	$\sin x$	$\cos x$	$\tan x$	$\cot x$	$\sec x$	$\csc x$
$f'(x)$	nx^{n-1}	0	$\cos x$	$-\sin x$	$\sec^2 x$	$-\csc^2 x$	$\sec x \tan x$	$-\csc x \cot x$

Polynomial: $\frac{d}{dx} (a_n x^n + a_{n-1} x^{n-1} + \dots + a_1 x + a_0) = na_n x^{n-1} + (n-1)a_{n-1} x^{n-2} + \dots + a_1$

★ FORMATIVE ONLY: CHAIN RULE

- $\frac{d}{dx} f(g(x)) = f'(g(x)) \cdot g'(x)$. Example: $\frac{d}{dx} \sin(x^2) = 2x \cos(x^2)$

13 Statistics**CENTRAL TENDENCY (RECALL)**

- Mean: $\bar{x} = \frac{\sum x_i}{n}$; for frequencies $\bar{x} = \frac{\sum f_i x_i}{N}$, $N = \sum f_i$
- Step deviation: $u_i = \frac{x_i - A}{h}$, $\bar{x} = A + \frac{\sum f_i u_i}{N} \times h$
- Median (ungrouped, sorted): n odd: $\left(\frac{n+1}{2}\right)$ th value;
 n even: mean of the $\frac{n}{2}$ th and $\left(\frac{n}{2} + 1\right)$ th values
- Median (grouped): $M = l + \frac{\frac{N}{2} - C}{f} \times h$

l = lower limit of the median class, C = cumulative frequency before it, f = its frequency, h = class width.

RANGE AND MEAN DEVIATION

- Range = maximum value – minimum value
- Ungrouped, about a : $M.D.(a) = \frac{\sum |x_i - a|}{n}$
- $M.D.(\bar{x}) = \frac{\sum |x_i - \bar{x}|}{n}$, $M.D.(M) = \frac{\sum |x_i - M|}{n}$
- Grouped: $M.D.(\bar{x}) = \frac{\sum f_i |x_i - \bar{x}|}{N}$
- Grouped: $M.D.(M) = \frac{\sum f_i |x_i - M|}{N}$

For continuous data, x_i is the mid-point of each class.

VARIANCE AND SD: UNGROUPED DATA

- $\sigma^2 = \frac{1}{n} \sum (x_i - \bar{x})^2$, $\sigma = \sqrt{\frac{1}{n} \sum (x_i - \bar{x})^2}$
- Equivalent: $\sigma^2 = \frac{\sum x_i^2}{n} - (\bar{x})^2$

VARIANCE AND SD: FREQUENCY DISTRIBUTIONS

- $\sigma^2 = \frac{1}{N} \sum f_i (x_i - \bar{x})^2$, $\sigma = \sqrt{\frac{1}{N} \sum f_i (x_i - \bar{x})^2}$
- $\sigma = \frac{1}{N} \sqrt{N \sum f_i x_i^2 - (\sum f_i x_i)^2}$

SHORTCUT (STEP-DEVIATION) METHOD

$$y_i = \frac{x_i - A}{h} \quad \sigma^2 = \frac{h^2}{N^2} \left[N \sum f_i y_i^2 - \left(\sum f_i y_i \right)^2 \right] \quad \sigma = \frac{h}{N} \sqrt{N \sum f_i y_i^2 - \left(\sum f_i y_i \right)^2}$$

A = assumed mean, h = class width. Adding a constant to every value does not change σ ; multiplying every value by k multiplies σ by $|k|$.



14 Probability

EVENTS (S = SAMPLE SPACE)

Event	Set
Impossible / sure	$\varnothing / S$
not A	$A' = S - A$
A or B	$A \cup B$
A and B	$A \cap B$
A but not B	$A - B = A \cap B'$

- Mutually exclusive: $A \cap B = \varnothing$
- Exhaustive: $E_1 \cup E_2 \cup \dots \cup E_n = S$; mutually exclusive and exhaustive if also $E_i \cap E_j = \varnothing$ for $i \neq j$

AXIOMATIC PROBABILITY

- $P(E) \geq 0$ for every event E ; $P(S) = 1$
- E, F mutually exclusive $\Rightarrow P(E \cup F) = P(E) + P(F)$
- For outcomes ω_i : $0 \leq P(\omega_i) \leq 1$, $\sum P(\omega_i) = 1$,
 $P(A) = \sum_{\omega_i \in A} P(\omega_i)$
- $P(\varnothing) = 0$; $0 \leq P(A) \leq 1$
- Equally likely outcomes: $P(A) = \frac{n(A)}{n(S)}$

RULES

- Addition rule: $P(A \cup B) = P(A) + P(B) - P(A \cap B)$, i.e. $P(A \text{ or } B) = P(A) + P(B) - P(A \text{ and } B)$
- Mutually exclusive: $P(A \cup B) = P(A) + P(B)$
- Complement: $P(\text{not } A) = P(A') = 1 - P(A)$
- $P(A \text{ but not } B) = P(A - B) = P(A) - P(A \cap B)$
- Mutually exclusive and exhaustive $E_1, \dots, E_n$: $P(E_1) + P(E_2) + \dots + P(E_n) = 1$
- Three events: $P(A \cup B \cup C) = P(A) + P(B) + P(C) - P(A \cap B) - P(B \cap C) - P(A \cap C) + P(A \cap B \cap C)$

★ FORMATIVE ONLY: RANDOM EXPERIMENTS

- Random experiment: more than one possible outcome, and the outcome cannot be predicted in advance.
Sample space S = set of all possible outcomes; each element is a sample point.

Made by StudyOS · Free CBSE study kit · studyos.co.in

