

Class XII

Mathematics

One-page chapter summaries
Large print • CBSE 2026-27 syllabus

1. Relations and Functions — page 2
2. Inverse Trigonometric Functions — page 3
3. Matrices — page 4
4. Determinants — page 5
5. Continuity and Differentiability — page 6
6. Application of Derivatives — page 7
7. Integrals — page 8
8. Application of Integrals — page 9
9. Differential Equations — page 10
10. Vector Algebra — page 11
11. Three Dimensional Geometry — page 12
12. Linear Programming — page 13
13. Probability — page 14

Chapter 1: Relations and Functions

Class XII • Mathematics • CBSE 2026-27

Big idea: A relation links elements of two sets; a function is a relation giving each input exactly one output.

Key points

- A **relation** R from A to B is any subset of $A \times B$; a relation on A is a subset of $A \times A$.
- **Empty relation**: $R = \emptyset$. **Universal relation**: $R = A \times A$.
- **Reflexive**: $(a, a) \in R$ for every $a \in A$.
- **Symmetric**: $(a, b) \in R \Rightarrow (b, a) \in R$.
- **Transitive**: $(a, b) \in R$ and $(b, c) \in R \Rightarrow (a, c) \in R$.
- **Equivalence relation = reflexive + symmetric + transitive**; it splits A into disjoint **equivalence classes**.
- **One-one (injective)**: $f(x_1) = f(x_2) \Rightarrow x_1 = x_2$. **Onto (surjective)**: range = codomain.
- **Bijjective** = one-one and onto.

Definitions & quick checks

- Equivalence class $[a] = \{x \in A : (x, a) \in R\}$
- Onto test: solve $y = f(x)$ for x and check x lies in the domain for every y in codomain
- Not one-one: find $x_1 \neq x_2$ with $f(x_1) = f(x_2)$ (e.g. $f(x) = x^2$ on $\mathbb{R}$: $f(-1) = f(1)$)
- A finite set $A \rightarrow A$: one-one $\Leftrightarrow$ onto

Exam focus: how to score

- **5-mark: prove a relation is an equivalence relation** — check all three properties with general elements.
- To disprove a property, one clear **counter-example** is enough.
- Injective/surjective questions: state domain and codomain clearly; codomain decides onto.
- Case studies (4 marks) give real situations (e.g. traffic flow) — write R as ordered pairs first.

★ Important questions from CBSE sample papers

- $A = \mathbb{N} \times \mathbb{N}$; $(a, b) R (c, d)$ iff $a^2 + d^2 = b^2 + c^2$. Check whether R is an equivalence relation. (SQP 2026-27, 5 marks)
- $R: (-\infty, \infty) \rightarrow [0, \infty)$, $R = \{(x, y): y = x^2 + 5\}$. Is it a function? If so, is it injective? surjective? (SQP 2026-27, 5 marks)
- Traffic flows $A \rightarrow B$, $A \rightarrow C$, $A \rightarrow D$, $B \rightarrow C$, $B \rightarrow E$, $C \rightarrow E$, $D \rightarrow E$, $D \rightarrow C$. Is the flow reflexive? transitive? Justify. (SQP 2025-26, 4 marks)

Remember: RST = Reflexive, Symmetric, Transitive $\rightarrow$ Equivalence.

Chapter 2: Inverse Trigonometric Functions

Class XII • Mathematics • CBSE 2026-27

Big idea: Trig functions become invertible only after restricting their domain to a principal value branch.

Key points

- Trig functions are not one-one on $\mathbb{R}$, so we restrict domains to make them **bijective** and then invert.
- $\sin^{-1}x$ is the **inverse function**, not $(\sin x)^{-1} = 1/\sin x$.
- The branch with the standard range is the **principal value branch**; its value is the **principal value**.
- Graph of $y = \sin^{-1}x$ is the graph of $y = \sin x$ reflected in the line **$y = x$** .
- $\sin(\sin^{-1}x) = x$ for $x \in [-1, 1]$; $\sin^{-1}(\sin x) = x$ only for $x \in [-\pi/2, \pi/2]$.
- Always give answers **inside the principal range**.

Domains & principal ranges (must learn)

- **$\sin^{-1}: [-1, 1] \rightarrow [-\pi/2, \pi/2]$ $\cos^{-1}: [-1, 1] \rightarrow [0, \pi]$**
- $\tan^{-1}: \mathbb{R} \rightarrow (-\pi/2, \pi/2)$ $\cot^{-1}: \mathbb{R} \rightarrow (0, \pi)$
- $\sec^{-1}: \mathbb{R} - (-1, 1) \rightarrow [0, \pi] - \{\pi/2\}$
- $\operatorname{cosec}^{-1}: \mathbb{R} - (-1, 1) \rightarrow [-\pi/2, \pi/2] - \{0\}$
- $\sin^{-1}(-x) = -\sin^{-1}x$; $\tan^{-1}(-x) = -\tan^{-1}x$
- $\cos^{-1}(-x) = \pi - \cos^{-1}x$; $\cot^{-1}(-x) = \pi - \cot^{-1}x$

Graphs to practise

- Graphs of $\sin^{-1}x$, $\cos^{-1}x$, $\tan^{-1}x$ (swap axes of $\sin$, $\cos$, $\tan$ on their principal branches)

Exam focus: how to score

- Mostly 1-mark MCQs and 2-mark questions: principal values, domains, graph identification.
- **Domain of $\sin^{-1}(g(x))$ or $\cos^{-1}(g(x))$: solve $-1 \leq g(x) \leq 1$** ; for $\sec^{-1}(g(x))$ solve $|g(x)| \geq 1$.
- Assertion-Reason often tests principal ranges.

★ Important questions from CBSE sample papers

- Domain of $\sec^{-1}(2x)$ is? (SQP 2026-27, 1 mark)
- Find the value of $\cot^{-1}(2 \cos(\sin^{-1}(\sqrt{3}/2)))$. (SQP 2026-27, 1 mark)
- Find the domain of $\cos^{-1}(3x - 2)$. (SQP 2025-26, 2 marks)
- Evaluate $\tan(\tan^{-1}(-1) + \pi/3)$. (SQP 2025-26, 2 marks)

Remember: $\sin$ & $\tan$: centre at 0 ($-\pi/2$ to $\pi/2$); $\cos$ & $\cot$: start at 0 (0 to π).

Chapter 3: Matrices

Class XII • Mathematics • CBSE 2026-27

Big idea: A matrix is an ordered rectangular array of numbers with its own rules of algebra.

Key points

- Order $m \times n$ = m rows, n columns; mn elements.
- Types: column, row, **square**, **diagonal**, **scalar**, **identity I**, **zero O**.
- Equal matrices: same order and every corresponding element equal.
- Add/subtract only matrices of the **same order**; kA multiplies every element by k .
- **AB is defined only if columns of A = rows of B** ; $(m \times n)(n \times p)$ gives $m \times p$.
- Multiplication is **not commutative**: $AB \neq BA$ in general; $AB = O$ is possible with $A \neq O$, $B \neq O$.
- **Transpose** A' : rows become columns.
- If $AB = BA = I$, B is the **inverse** of A ; the inverse, if it exists, is **unique**.

Properties to remember

- $(A')' = A$, $(kA)' = kA'$, $(A + B)' = A' + B'$
- **$(AB)' = B'A'$**
- **Symmetric**: $A' = A$. **Skew symmetric**: $A' = -A$ (diagonal elements are 0)
- $A = \frac{1}{2}(A + A') + \frac{1}{2}(A - A')$ (symmetric + skew symmetric)
- $A(BC) = (AB)C$, $A(B + C) = AB + AC$, $IA = AI = A$
- $(AB)^{-1} = B^{-1}A^{-1}$

Exam focus: how to score

- 1-mark MCQs: order of product, symmetric matrix entries, solving for unknowns by equality.
- Show each element of a product clearly (row $\times$ column); arithmetic slips cost marks.
- **Express a matrix as sum of symmetric and skew symmetric parts** — a favourite.

★ Important questions from CBSE sample papers

- $A = \begin{bmatrix} 2 & 1 & -2 \\ 3a & 0 & 4 \\ b & 2c & 1 \end{bmatrix}$ is symmetric. Find $\sqrt{6a + 2b + 3c}$. (SQP 2026-27, 1 mark)
- If $[1 \ x] \cdot \begin{bmatrix} 1 & 0 \\ 0 & 2 \end{bmatrix} \cdot \begin{bmatrix} 4 \\ -1 \end{bmatrix} = 0$, find x . (SQP 2026-27, 1 mark)
- $P = \begin{bmatrix} 2 & 0 & 0 \\ 0 & 1 & 2 \end{bmatrix}$, $Q = \begin{bmatrix} 1 & 0 \\ 0 & 2 \\ 1 & 0 \end{bmatrix}$: find PQ and QP (whichever defined) and the inverse of the product if it exists. (SQP 2026-27, 3 marks)

Remember: Rows of the first $\times$ columns of the second; order matters.

Chapter 4: Determinants

Class XII • Mathematics • CBSE 2026-27

Big idea: Every square matrix has a number, its determinant, that tells us if it is invertible and solves equations.

Key points

- Determinant defined for **square matrices** only; $|A|$ for orders 1, 2, 3.
- Expand a 3×3 along any row or column — pick the one with most zeros.
- **Minor** M_{ij} : determinant left after deleting row i , column j . **Cofactor** $A_{ij} = (-1)^{i+j} M_{ij}$.
- **adj A** = transpose of the cofactor matrix.
- A is **singular** if $|A| = 0$; **A^{-1} exists only if $|A| \neq 0$ (non-singular)**.
- Area of triangle from vertices; area is zero $\Rightarrow$ points are **collinear**.
- System $AX = B$: unique solution $X = A^{-1}B$ when $|A| \neq 0$.

Formulas

- $\begin{vmatrix} a & b \\ c & d \end{vmatrix} = ad - bc$
- $\Delta = a_{11}A_{11} + a_{12}A_{12} + a_{13}A_{13}$ (expansion by cofactors)
- **$A^{-1} = (1/|A|) \cdot \text{adj } A$** ; $A(\text{adj } A) = (\text{adj } A)A = |A| I$
- $|\text{adj } A| = |A|^{n-1}$ (order n); $|AB| = |A||B|$; $|kA| = k^n|A|$
- Area = $\frac{1}{2} |x_1(y_2 - y_3) + x_2(y_3 - y_1) + x_3(y_1 - y_2)|$ (take absolute value)
- $|A| = 0$ and $(\text{adj } A)B \neq O \Rightarrow$ no solution (inconsistent); $|A| = 0$ and $(\text{adj } A)B = O \Rightarrow$ infinitely many or none

Exam focus: how to score

- **5-mark: solve a system of 3 equations using matrix inverse** — write $AX = B$, find $|A|$, $\text{adj } A$, A^{-1} , then X .
- Check your A^{-1} by verifying $AA^{-1} = I$ if time permits.
- Case study: form equations from a word problem (baskets, prices) into matrix form.

★ Important questions from CBSE sample papers

- $P = \begin{bmatrix} 2 & 1 \\ 0 & 1 \end{bmatrix}$ and $|Q| = 3$ (same order). Find $|\text{adj}(PQ)|$. (SQP 2026-27, 1 mark)
- Baskets A, B, C with given kg of apples, oranges, pomegranates cost ₹2750, ₹3500, ₹4100. Write matrix form, find adjoint, and price per kg using inverse. (SQP 2026-27, 4 marks)
- $A = \begin{bmatrix} 3 & -6 & -1 \\ 2 & -5 & -1 \\ -2 & 4 & 1 \end{bmatrix}$, $B = \begin{bmatrix} 1 & -2 & -1 \\ 0 & -1 & -1 \\ 2 & 0 & 3 \end{bmatrix}$: find AB and hence solve $3x - 6y - z = 3$, $2x - 5y - z + 2 = 0$, $-2x + 4y + z = 5$. (SQP 2025-26, 5 marks)

Remember: Inverse = adjoint $\div$ determinant (never divide by zero).

Chapter 5: Continuity and Differentiability

Class XII • Mathematics • CBSE 2026-27

Big idea: A function is continuous if its graph has no break; differentiable if it is also smooth (no sharp corner).

Key points

- f is **continuous at c** if $\lim_{(x \rightarrow c)} f(x) = f(c)$: $\text{LHL} = \text{RHL} = f(c)$.
- Sum, difference, product, quotient (denominator $\neq 0$) of continuous functions are continuous.
- **Differentiable $\Rightarrow$ continuous, but not conversely** ($|x|$ is continuous, not differentiable at 0).
- **Chain rule** for composite functions: $\frac{d}{dx} f(g(x)) = f'(g(x)) \cdot g'(x)$.
- **Implicit** functions: differentiate both sides w.r.t. x , collect dy/dx .
- **Logarithmic differentiation** for $[u(x)]^{v(x)}$ or long products: take log first.
- **Parametric**: $x = f(t)$, $y = g(t) \Rightarrow \frac{dy}{dx} = \frac{(dy/dt)}{(dx/dt)}$.
- **Second derivative** $\frac{d^2y}{dx^2} = \frac{d}{dx}(\frac{dy}{dx})$.

Derivatives to know

- $\frac{d}{dx}(\sin^{-1}x) = \frac{1}{\sqrt{1-x^2}}$; $\frac{d}{dx}(\cos^{-1}x) = -\frac{1}{\sqrt{1-x^2}}$
- $\frac{d}{dx}(\tan^{-1}x) = \frac{1}{1+x^2}$
- $\frac{d}{dx}(e^x) = e^x$; $\frac{d}{dx}(\log x) = \frac{1}{x}$ ($x > 0$)
- $\frac{d}{dx}(a^x) = a^x \log a$
- Parametric 2nd derivative: $\frac{d^2y}{dx^2} = \frac{d}{dt}(\frac{dy}{dx}) \div (\frac{dx}{dt})$

Exam focus: how to score

- Continuity/differentiability at a point of a piecewise function: find k from $\text{LHL} = \text{RHL} = f(c)$.
- **3-mark: logarithmic differentiation of $x^{\log x} + (\log x)^x$ type** — split into $u + v$ and differentiate each.
- Parametric $\frac{d^2y}{dx^2}$: don't forget to divide by dx/dt again.
- Write each step; marks are split $\frac{1}{2} + 1 + \frac{1}{2}$ per step in schemes.

★ Important questions from CBSE sample papers

- $f(x) = ax^2 + b$ ($x \leq 1$), $bx^2 + ax + c$ ($x > 1$), $b \neq 0$, is differentiable at $x = 1$. Which triplet (a, b, c) is possible? (SQP 2026-27, 1 mark)
- If $y = \sin(x + y)$ and $\frac{dy}{dx} = 0$, prove that $y = \pm 1$. (SQP 2026-27, 2 marks)
- If $y = x^{(\log x)} + (\log x)^x$, $x > 1$, find $\frac{dy}{dx}$. (SQP 2026-27, 3 marks)
- If $x = a(\theta - \sin \theta)$, $y = a(1 - \cos \theta)$, find $\frac{d^2y}{dx^2}$. (SQP 2025-26, 3 marks)

Remember: $\text{LHL} = \text{RHL} = f(c)$ means continuous; corners kill differentiability.

Chapter 6: Application of Derivatives

Class XII • Mathematics • CBSE 2026-27

Big idea: The derivative measures rate of change and finds where functions rise, fall and peak.

Key points

- dy/dx = **rate of change** of y w.r.t. x ; $dy/dt = (dy/dx)(dx/dt)$ for related rates.
- $f'(x) > 0$ on an interval $\Rightarrow$ **strictly increasing**; $f'(x) < 0 \Rightarrow$ **strictly decreasing**.
- $f'(x) = 0$ points are **critical / stationary points**; they split the number line into intervals.
- **First derivative test**: f' changes $+$ to $- \Rightarrow$ local maximum; $-$ to $+$ $\Rightarrow$ local minimum.
- **Second derivative test**: $f'(c) = 0$ and $f''(c) < 0 \Rightarrow$ **maximum**; $f''(c) > 0 \Rightarrow$ **minimum**.
- $f''(c) = 0$: test fails, use first derivative test.
- **Absolute max/min on $[a, b]$** : compare f at critical points and at end points a, b .

Useful results

- Circle: $A = \pi r^2$, $C = 2\pi r$. Sphere: $V = (4/3)\pi r^3$, $S = 4\pi r^2$
- Cone: $V = (1/3)\pi r^2 h$. Cylinder: $V = \pi r^2 h$
- Profit $P(x) = R(x) - C(x)$

Exam focus: how to score

- Related rates (3 marks): write the formula, differentiate w.r.t. t , then substitute values (not before!).
- Increasing/decreasing: factorise $f'(x)$, mark critical points, test signs in each interval.
- **Case study on maxima (profit, WQI, cost): stationary point $\rightarrow$ second derivative test $\rightarrow$ value.**
- Optimisation word problems: write the quantity in one variable before differentiating.

★ Important questions from CBSE sample papers

- Values of x for which the derivative of $y = x^4$ is greater than y . (SQP 2026-27, 1 mark)
- A drone's circular area of vision grows at 44 m^2 per metre of height; radius grows at 6 m/s . Find rate of rise of height when $r = 14 \text{ m}$. (SQP 2026-27, 3 marks)
- WQI $W(x) = 35 + 1.6x - 0.02x^2$: find the stationary point and maximum WQI by second derivative test. (SQP 2026-27, 4 marks)
- A melting ice ball loses volume at a rate proportional to its surface area. Prove its radius decreases at a constant rate. (SQP 2025-26, 3 marks)

Remember: Slope + up, slope – down; f'' negative = peak (frown), positive = valley (smile).

Chapter 7: Integrals

Class XII • Mathematics • CBSE 2026-27

Big idea: Integration reverses differentiation (antiderivatives) and finds the limit of a sum (definite integral).

Key points

- $\int f(x)dx = F(x) + C$ where $F'(x) = f(x)$; C is the constant of integration.
- Methods: **substitution, trig identities, partial fractions, integration by parts.**
- **Partial fractions** for proper rational functions; divide first if improper.
- **By parts** (ILATE order to choose first function): $\int u v dx = u \int v dx - \int (u' \int v dx) dx$.
- **Fundamental Theorem:** $\int_a^b f(x)dx = F(b) - F(a)$.
- Definite integral needs **no + C**; change limits when you substitute.

Standard integrals & properties

- $\int dx/(x^2 - a^2) = (1/2a) \log|(x - a)/(x + a)| + C$; $\int dx/(x^2 + a^2) = (1/a) \tan^{-1}(x/a) + C$
- $\int dx/\sqrt{a^2 - x^2} = \sin^{-1}(x/a) + C$; $\int dx/\sqrt{x^2 \pm a^2} = \log|x + \sqrt{x^2 \pm a^2}| + C$
- $\int \sqrt{a^2 - x^2} dx = (x/2)\sqrt{a^2 - x^2} + (a^2/2) \sin^{-1}(x/a) + C$
- **$\int e^x[f(x) + f'(x)]dx = e^x f(x) + C$**
- **$\int_a^b f(x)dx = \int_a^b f(a + b - x)dx$; $\int_0^a f(x)dx = \int_0^a f(a - x)dx$**
- $\int_{-a}^a f = 2\int_0^a f$ if f even; $= 0$ if f odd
- $\int_0^{2a} f = 2\int_0^a f$ if $f(2a - x) = f(x)$; $= 0$ if $f(2a - x) = -f(x)$

Exam focus: how to score

- Biggest unit (Calculus = 35 marks): expect 2, 3 and 5-mark integrals.
- **Definite integrals using property $f(a + b - x)$** — add the two forms of I to get $2I$.
- For $|x - k|$ integrals, split the limits where the expression changes sign.
- Write substitution and new limits explicitly; marking schemes give $\frac{1}{2}$ mark for them.

★ Important questions from CBSE sample papers

- If $\int dx/(1 + e^{2x}) = x - P \log(1 + e^{2x}) + C$, find P . (SQP 2026-27, 1 mark)
- Evaluate $\int dx / (x\sqrt{x^6 - 1})$. (SQP 2026-27, 2 marks)
- Evaluate $\int$ from $-a$ to a of $\sqrt{(a - x)/(a + x)} dx$. (SQP 2026-27, 5 marks)
- Evaluate $\int_0^1 \log(1 + x)/(1 + x^2) dx$. (SQP 2025-26, 5 marks)

Remember: ILATE picks u ; $a + b - x$ simplifies definite integrals.

Chapter 8: Application of Integrals

Class XII • Mathematics • CBSE 2026-27

Big idea: Definite integrals give the area enclosed between curves, lines and the axes.

Key points

- Area between $y = f(x)$, x-axis, $x = a$, $x = b$: $A = \int_a^b y \, dx$.
- Area between $x = g(y)$, y-axis, $y = c$, $y = d$: $A = \int_c^d x \, dy$.
- If the curve is **below** the x-axis, the integral is negative — take its **absolute value**.
- Part above and part below the axis: find each area separately and add.
- Curves in syllabus: **lines, circles, parabolas, ellipses** (standard form only).
- Use **symmetry** (e.g. $4 \times$ first-quadrant area for circle/ellipse).
- Always find **points of intersection** first to fix limits.

Results worth knowing

- Circle $x^2 + y^2 = a^2$: area $= \pi a^2$
- **Ellipse $x^2/a^2 + y^2/b^2 = 1$: area $= \pi ab$** ($A = 4 \int_0^a (b/a) \sqrt{a^2 - x^2} \, dx$)
- Between two curves: $A = \int_a^b [f(x) - g(x)] \, dx$ with $f \geq g$
- $\int_0^a \sqrt{a^2 - x^2} \, dx = \pi a^2/4$

Sketches to practise

- Shade the region for: parabola $y^2 = 4ax$ with a line; circle with a line; ellipse; $y = |x + 1|$ over an interval

Exam focus: how to score

- **Always draw a neat sketch and shade the region** — it carries marks in 5-mark answers.
- Steps rewarded: correct figure, intersection points, correct integral set-up, evaluation.
- Write final answer in **square units**.

★ Important questions from CBSE sample papers

- Using integration, find the area of the region $\{(x, y): 0 \leq y \leq \sqrt{4 - x^2}, x \geq 2 - y\}$. (SQP 2026-27, 5 marks)
- Using integration, find the area bounded by $y^2 = 2x$ and the line $x - 2y = 0$. (SQP 2026-27, 5 marks)
- Sketch $y = |x + 1|$, evaluate $\int_{-4}^2 |x + 1| \, dx$, and say what the value represents. (SQP 2025-26, 3 marks)

Remember: Sketch → intersect → integrate → square units.

Chapter 9: Differential Equations

Class XII • Mathematics • CBSE 2026-27

Big idea: Equations involving derivatives; solving them gives a family of curves or one particular curve.

Key points

- **Order** = order of the highest derivative present.
- **Degree** = power of the highest-order derivative, when the equation is a **polynomial in derivatives**; else not defined.
- **General solution** has arbitrary constants (a family of curves); **particular solution** has none (use given condition).
- **Variables separable**: write as $g(y)dy = f(x)dx$ and integrate both sides.
- **Homogeneous**: $dy/dx = F(x, y)$ with $F(\lambda x, \lambda y) = F(x, y)$; put $y = vx$.
- **Linear**: $dy/dx + Py = Q$ (P, Q functions of x or constants).
- Linear in x : $dx/dy + P_1x = Q_1$ (P_1, Q_1 functions of y) — use I.F. = $e^{\int P_1 dy}$.

Solution recipes

- Homogeneous: $y = vx \Rightarrow dy/dx = v + x dv/dx$
- **Integrating factor I.F. = $e^{\int P dx}$**
- **Solution: $y \times (\text{I.F.}) = \int (Q \times \text{I.F.}) dx + C$**
- For dx/dy form: $x \times (\text{I.F.}) = \int (Q_1 \times \text{I.F.}) dy + C$

Exam focus: how to score

- Identify the type first; wrong type = wrong method.
- Linear DE (3–5 marks): bring to standard form $dy/dx + Py = Q$ before finding P .
- Particular solution: substitute the given condition to find C — easy mark, don't skip.
- Order/degree MCQs: remove radicals/fractions in derivatives before judging degree.

★ Important questions from CBSE sample papers

- Find the particular solution of $x dy + (y - x^2 e^x) dx = 0$, given $y(1) = 0$. (SQP 2026-27, 3 marks)
- Find the particular solution of $(x^2 + y^2) dy = xy dx$, given $y(0) = 1$. (SQP 2026-27, 3 marks)
- Solve $y + d/dx(xy) = x(\sin x + x)$. (SQP 2025-26, 5 marks)
- The solution of $x dx + y dy = 0$ represents a family of: lines / parabolas / circles / ellipses? (SQP 2025-26, 1 mark)

Remember: Separate, substitute ($y = vx$), or multiply by $e^{\int P dx}$.

Chapter 10: Vector Algebra

Class XII • Mathematics • CBSE 2026-27

Big idea: Vectors have magnitude and direction; dot and cross products measure angles, projections and areas.

Key points

- Position vector of $P(x, y, z)$: $\mathbf{r} = x\hat{i} + y\hat{j} + z\hat{k}$; $|\mathbf{r}| = \sqrt{x^2 + y^2 + z^2}$.
- **Direction cosines** l, m, n : cosines of angles with axes; $l^2 + m^2 + n^2 = 1$.
- Types: **zero, unit, co-initial, collinear, equal, negative** vectors.
- Vector $\mathbf{AB} = (x_2 - x_1)\hat{i} + (y_2 - y_1)\hat{j} + (z_2 - z_1)\hat{k}$.
- Addition by **triangle / parallelogram law**.
- **Section formula**: point dividing PQ in $m : n$ internally has p.v. $(m\mathbf{b} + n\mathbf{a})/(m + n)$.
- $\mathbf{a} \cdot \mathbf{b} = 0 \Leftrightarrow \mathbf{a} \perp \mathbf{b}$; $\mathbf{a} \times \mathbf{b} = 0 \Leftrightarrow \mathbf{a} \parallel \mathbf{b}$ (non-zero vectors).
- $\mathbf{a} \times \mathbf{b}$ is **perpendicular** to both $\mathbf{a}$ and $\mathbf{b}$; $\mathbf{b} \times \mathbf{a} = -(\mathbf{a} \times \mathbf{b})$.

Formulas

- Unit vector $\hat{\mathbf{a}} = \mathbf{a}/|\mathbf{a}|$
- **$\mathbf{a} \cdot \mathbf{b} = |\mathbf{a}||\mathbf{b}| \cos \theta = a_1b_1 + a_2b_2 + a_3b_3$**
- Projection of $\mathbf{a}$ on $\mathbf{b} = (\mathbf{a} \cdot \mathbf{b})/|\mathbf{b}|$
- $\mathbf{a} \times \mathbf{b} = |\mathbf{a}||\mathbf{b}| \sin \theta \hat{\mathbf{n}} = \text{determinant } \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ a_1 & a_2 & a_3 \\ b_1 & b_2 & b_3 \end{vmatrix}$
- **Area of parallelogram (adjacent sides $\mathbf{a}, \mathbf{b}$) = $|\mathbf{a} \times \mathbf{b}|$; triangle = $\frac{1}{2}|\mathbf{a} \times \mathbf{b}|$**
- $|\mathbf{a} \times \mathbf{b}|^2 + (\mathbf{a} \cdot \mathbf{b})^2 = |\mathbf{a}|^2|\mathbf{b}|^2$

Exam focus: how to score

- Common MCQs: magnitude, unit vector, angle with an axis, perpendicular vector.
- 2-mark: use $|\mathbf{a} \times \mathbf{b}|^2 + (\mathbf{a} \cdot \mathbf{b})^2 = |\mathbf{a}|^2|\mathbf{b}|^2$ to find a magnitude quickly.
- Area of triangle/parallelogram via cross product — show the determinant.

★ Important questions from CBSE sample papers

- If $2\hat{i} - u\hat{j} + 3\hat{k}$ has magnitude 4, find u . (SQP 2026-27, 1 mark)
- $|\mathbf{a}| = \sqrt{6}$, $\mathbf{a} \cdot \mathbf{b} = 1$ and $\mathbf{b} \times \mathbf{a} = 3\hat{i} + 4\hat{j} - 2\hat{k}$. Find $|\mathbf{b}|$. (SQP 2026-27, 2 marks)
- $\mathbf{OA} = \hat{i} + \hat{j} + \hat{k}$, $\mathbf{OB} = 3\hat{i} - \hat{j} + 3\hat{k}$; OP is a median of $\triangle OAB$. Find area of parallelogram with sides OA and OP. (SQP 2025-26, 2 marks)

Remember: Dot gives a number (cos); cross gives a vector (sin, area).

Chapter 11: Three Dimensional Geometry

Class XII • Mathematics • CBSE 2026-27

Big idea: Lines in space are described by a point and a direction; we find angles and distances between them.

Key points

- **Direction ratios** a, b, c are proportional to direction cosines l, m, n .
- Line through (x_1, y_1, z_1) and (x_2, y_2, z_2) has d.r.s $x_2 - x_1, y_2 - y_1, z_2 - z_1$.
- Vector equation of line: $r = a + \lambda b$ (through point a , parallel to b).
- Cartesian: $(x - x_1)/a = (y - y_1)/b = (z - z_1)/c$.
- **Skew lines**: neither parallel nor intersecting (lie in different planes).
- Lines $\perp \Leftrightarrow a_1a_2 + b_1b_2 + c_1c_2 = 0$; parallel $\Leftrightarrow a_1/a_2 = b_1/b_2 = c_1/c_2$.
- Foot of perpendicular from a point: take a general point on the line, use dot product = 0.

Formulas

- $l = a/\sqrt{a^2 + b^2 + c^2}$, similarly m, n
- Angle between lines: $\cos \theta = |a_1a_2 + b_1b_2 + c_1c_2| / (\sqrt{a_1^2 + b_1^2 + c_1^2} \sqrt{a_2^2 + b_2^2 + c_2^2})$
- **Shortest distance (skew):** $d = |(\mathbf{b}_1 \times \mathbf{b}_2) \cdot (\mathbf{a}_2 - \mathbf{a}_1)| / |\mathbf{b}_1 \times \mathbf{b}_2|$
- **Parallel lines** $r = \mathbf{a}_1 + \lambda \mathbf{b}$, $r = \mathbf{a}_2 + \mu \mathbf{b}$: $d = |\mathbf{b} \times (\mathbf{a}_2 - \mathbf{a}_1)| / |\mathbf{b}|$
- Lines intersect $\Leftrightarrow$ shortest distance = 0

Exam focus: how to score

- Convert Cartesian to standard form first: coefficient of x, y, z must be 1 (e.g. $(2y + 3)/4 \rightarrow (y + 3/2)/2$; $2 - z \rightarrow (z - 2)/(-1)$).
- Case study: check parallel/not parallel from direction ratios, then shortest distance (2 marks).
- Line $\perp$ to two lines: direction = $\mathbf{b}_1 \times \mathbf{b}_2$.

★ Important questions from CBSE sample papers

- Angle made by $\hat{i} + \hat{j} + \sqrt{2} \hat{k}$ with the positive z -axis. (SQP 2026-27, 1 mark)
- Line through $(2, 6, 5)$ and $(3, p, 7)$ is parallel to line joining $(-4, 3, 4)$ and $(-1, 0, q)$. Find q/p . (SQP 2026-27, 2 marks)
- Find the foot of perpendicular from $(2, 1, 4)$ on $x - 2 = (2y + 3)/4 = 2 - z$, and the line through it and $(2, 1, 4)$. (SQP 2026-27, 3 marks)
- Laser beams $l_1: r = (\lambda + 1)\hat{i} + (3\lambda + 2)\hat{j} + (3 - \lambda)\hat{k}$, $l_2: r = 2(\mu + 1)\hat{i} + (3\mu - 1)\hat{j} + (\mu + 1)\hat{k}$. Show not parallel; find shortest distance. (SQP 2026-27, 4 marks)

Remember: Point + direction = line; cross the directions for shortest distance.

Chapter 12: Linear Programming

Class XII • Mathematics • CBSE 2026-27

Big idea: Maximise or minimise a linear objective under linear constraints by checking corner points.

Key points

- **Objective function** $Z = ax + by$ is optimised; x, y are **decision variables**.
- **Constraints**: linear inequalities; **non-negative restrictions** $x \geq 0, y \geq 0$.
- **Feasible region**: common region of all constraints; points in it are **feasible solutions**.
- **Corner Point Theorem: optimal value (if it exists) occurs at a corner point of the feasible region.**
- **Bounded** region: both max and min exist.
- If max (min) occurs at two corners, it occurs at **every point** on the segment joining them.

Corner point method

- 1. Draw constraint lines; shade feasible region
- 2. Find all corner points (solve pairs of lines)
- 3. Evaluate Z at each corner; pick largest/smallest
- **Unbounded region, max M found: check if $ax + by > M$ has any common point with region; if none, M is the max**
- (For min m : check $ax + by < m$)

Graph to practise

- Graph lines like $x + y = 6, y = 2x, y = 2$; test origin to decide which side to shade

Exam focus: how to score

- 3-mark graphical LPP: correct graph + corner points + table of Z values + conclusion.
- Label lines and corner points clearly on the graph.
- For unbounded regions, the extra open half-plane check is often required for full marks.
- Reading constraints off a given graph is a common 2-mark/1-mark question.

★ Important questions from CBSE sample papers

- Solve graphically: Maximise $Z = 40x + 30y$ subject to $x + y \leq 6, 2x \geq y, y \geq 2$. (SQP 2026-27, 3 marks)
- Feasible region of an LPP is shown in a figure: write all the constraints on the decision variables. (SQP 2026-27, 2 marks)
- Maximise $Z = 2x + y$ subject to $x + y \leq 1200, x + y \geq 600, y \leq x/2, x \geq 0, y \geq 0$. (SQP 2025-26, 3 marks)

Remember: Graph, corners, table, conclude.

Chapter 13: Probability

Class XII • Mathematics • CBSE 2026-27

Big idea: Conditional probability updates chances using new information; Bayes' theorem works backwards from effect to cause.

Key points

- **Conditional probability** $P(E|F)$: probability of E given F has occurred, $P(F) \neq 0$.
- $P(S|F) = P(F|F) = 1$; $P(E'|F) = 1 - P(E|F)$.
- **Multiplication theorem**: $P(E \cap F) = P(F) P(E|F) = P(E) P(F|E)$.
- **Independent events**: $P(E \cap F) = P(E) P(F)$; then E' and F' etc. are also independent.
- Independent $\neq$ mutually exclusive (exclusive means $P(E \cap F) = 0$).
- **Partition**: $E_1, \dots, E_n$ pairwise disjoint, union = S, each $P(E_i) > 0$.
- Random variables and distributions are **not** in the 2026-27 syllabus.

Formulas

- $P(E|F) = P(E \cap F) / P(F)$
- $P(E \cup F) = P(E) + P(F) - P(E \cap F)$
- Exactly one of A, B: $P(A)P(B') + P(A')P(B)$ (if independent)
- **Total probability**: $P(A) = \sum P(E_i) P(A|E_i)$
- **Bayes**: $P(E_i|A) = P(E_i)P(A|E_i) / \sum P(E_j)P(A|E_j)$

Exam focus: how to score

- Bayes' theorem (5 marks or case study): define events $E_1, E_2, \dots$ and A in words first.
- Make a table of $P(E_i)$ and $P(A|E_i)$ — reduces errors and earns step marks.
- Conditional MCQs on dice/cards: list the reduced sample space.

★ Important questions from CBSE sample papers

- A die is thrown twice. Find $P(\text{at least one } 4 \mid \text{sum is a multiple of } 5)$. (SQP 2026-27, 1 mark)
- A, B independent, $P(A) = 1/6$, $P(B) = k$; $P(\text{exactly one occurs}) = 1/3$. Find k. (SQP 2026-27, 1 mark)
- Smartwatch users: Alpha 45%, Beta 30%, Gamma 15%, Delta 10%; false alert rates 0.01, 0.02, 0.05, 0.01. Find $P(\text{false alert})$ and $P(\text{Beta} \mid \text{false alert})$. (SQP 2026-27, 5 marks)
- $P(\text{Mehul selected}) = 0.4$, $P(\text{exactly one selected}) = 0.5$, independent. Find $P(\text{Rashi selected})$ and $P(\text{at least one})$. (SQP 2025-26, 3 marks)

Remember: Given F? Divide by P(F). From effect to cause? Bayes.