



FORMULA SHEET · CLASS 11 AND 12

JEE Maths Formula Sheet

The results you are expected to know without deriving them in the exam hall, from quadratic roots to shortest distances between skew lines. Every line here comes up in JEE Main papers year after year.

JEE

CBSE 12

01 Algebra

Quadratic roots – $x = [-b \pm \sqrt{(b^2 - 4ac)}]/2a$; $\alpha + \beta = -b/a$, $\alpha\beta = c/a$

Nature of roots – $D > 0$ real and distinct; $D = 0$ equal; $D < 0$ complex

Arithmetic progression – $a_n = a + (n - 1)d$, $S_n = (n/2)[2a + (n - 1)d]$

Geometric progression – $a_n = ar^{n-1}$, $S_n = a(r^n - 1)/(r - 1)$, $S_\infty = a/(1 - r)$ for $|r| < 1$

Means – $AM \geq GM \geq HM$ for positive numbers

Sums – $\Sigma n = n(n + 1)/2$, $\Sigma n^2 = n(n + 1)(2n + 1)/6$, $\Sigma n^3 = [n(n + 1)/2]^2$

Binomial theorem – $(x + y)^n = \Sigma {}^nC_r x^{n-r}y^r$; general term $T_{r+1} = {}^nC_r x^{n-r}y^r$

Logarithms – $\log(xy) = \log x + \log y$; $\log_a x = \log_b x / \log_b a$

02 Counting and probability

Permutations – ${}^nP_r = n!/(n - r)!$

Combinations – ${}^nC_r = n!/[r!(n - r)!]$; ${}^nC_r + {}^nC_{r-1} = {}^{n+1}C_r$

Circular arrangements – $(n - 1)!$

Addition rule – $P(A \cup B) = P(A) + P(B) - P(A \cap B)$

Conditional probability – $P(A|B) = P(A \cap B)/P(B)$

Bayes' theorem – $P(A_i|B) = P(B|A_i)P(A_i) / \Sigma P(B|A_j)P(A_j)$

Random variable – mean $\mu = \Sigma x_i p_i$, variance $\sigma^2 = \Sigma x_i^2 p_i - \mu^2$; binomial: mean np , variance npq

03 Complex numbers

Forms – $z = x + iy = r(\cos\theta + i \sin\theta) = re^{i\theta}$, $|z| = \sqrt{(x^2 + y^2)}$

Conjugate – $z \bar{z} = |z|^2$

De Moivre – $(\cos\theta + i \sin\theta)^n = \cos n\theta + i \sin n\theta$

Cube roots of unity – $1, \omega, \omega^2$; $1 + \omega + \omega^2 = 0$, $\omega^3 = 1$

Triangle inequality – $|z_1 + z_2| \leq |z_1| + |z_2|$

04 Trigonometry

Identities – $\sin^2\theta + \cos^2\theta = 1$; $1 + \tan^2\theta = \sec^2\theta$; $1 + \cot^2\theta = \operatorname{cosec}^2\theta$

Compound angles – $\sin(A \pm B) = \sin A \cos B \pm \cos A \sin B$; $\cos(A \pm B) = \cos A \cos B \mp \sin A \sin B$

$\tan(A \pm B)$ – $(\tan A \pm \tan B)/(1 \mp \tan A \tan B)$

Double angle – $\sin 2A = 2\sin A \cos A$; $\cos 2A = 1 - 2\sin^2 A = 2\cos^2 A - 1$; $\tan 2A = 2\tan A/(1 - \tan^2 A)$

Triple angle – $\sin 3A = 3\sin A - 4\sin^3 A$; $\cos 3A = 4\cos^3 A - 3\cos A$

Sum to product – $\sin C + \sin D = 2\sin[(C + D)/2]\cos[(C - D)/2]$; $\cos C + \cos D = 2\cos[(C + D)/2]\cos[(C - D)/2]$

Sine and cosine rules – $a/\sin A = b/\sin B = c/\sin C = 2R$; $c^2 = a^2 + b^2 - 2ab \cos C$

General solutions – $\sin\theta = \sin\alpha \Rightarrow \theta = n\pi + (-1)^n\alpha$; $\cos\theta = \cos\alpha \Rightarrow \theta = 2n\pi \pm \alpha$; $\tan\theta = \tan\alpha \Rightarrow \theta = n\pi + \alpha$

05 Coordinate geometry

Distance – $\sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2}$

Section formula – $[(mx_2 + nx_1)/(m + n), (my_2 + ny_1)/(m + n)]$

Lines – $y = mx + c$; $y - y_1 = m(x - x_1)$; $\tan\theta = |(m_1 - m_2)/(1 + m_1 m_2)|$

Point to line distance – $|ax_1 + by_1 + c|/\sqrt{(a^2 + b^2)}$

Area of a triangle – $\frac{1}{2}|x_1(y_2 - y_3) + x_2(y_3 - y_1) + x_3(y_1 - y_2)|$

Circle – $x^2 + y^2 + 2gx + 2fy + c = 0$, centre $(-g, -f)$, $r = \sqrt{(g^2 + f^2 - c)}$

Parabola $y^2 = 4ax$ – focus $(a, 0)$, directrix $x = -a$, latus rectum $4a$, tangent $y = mx + a/m$

Ellipse $x^2/a^2 + y^2/b^2 = 1$ ($a > b$) – $e = \sqrt{(1 - b^2/a^2)}$, foci $(\pm ae, 0)$, latus rectum $2b^2/a$

Hyperbola $x^2/a^2 - y^2/b^2 = 1$ – $e = \sqrt{(1 + b^2/a^2)}$, asymptotes $y = \pm(b/a)x$

06 Limits and derivatives

Standard limits – $\sin x/x \rightarrow 1$; $(e^x - 1)/x \rightarrow 1$; $\ln(1+x)/x \rightarrow 1$ as $x \rightarrow 0$; $(1 + 1/x)^x \rightarrow e$ as $x \rightarrow \infty$

Power limit – $\lim_{x \rightarrow a} (x^n - a^n)/(x - a) = na^{n-1}$

Derivatives – $x^n \rightarrow nx^{n-1}$; $e^x \rightarrow e^x$; $\ln x \rightarrow 1/x$; $\sin x \rightarrow \cos x$; $\cos x \rightarrow -\sin x$; $\tan x \rightarrow \sec^2 x$

Inverse trig – $\sin^{-1}x \rightarrow 1/\sqrt{1-x^2}$; $\tan^{-1}x \rightarrow 1/(1+x^2)$

Rules – $(uv)' = u'v + uv'$; $(u/v)' = (u'v - uv')/v^2$; $dy/dx = (dy/du)(du/dx)$

Maxima and minima – $f'(x) = 0$ with $f''(x) < 0$ gives a maximum, $f''(x) > 0$ a minimum

Mean value theorem – $f'(c) = [f(b) - f(a)]/(b - a)$ for some c in (a, b)

07 Integrals

Standard forms – $\int x^n dx = x^{n+1}/(n+1) + C$ ($n \neq -1$); $\int dx/x = \ln|x| + C$; $\int a^x dx = a^x/\ln a + C$

Trigonometric – $\int \sin x dx = -\cos x + C$; $\int \cos x dx = \sin x + C$; $\int \sec^2 x dx = \tan x + C$; $\int \tan x dx = \ln|\sec x| + C$

Special forms – $\int dx/(x^2 + a^2) = (1/a)\tan^{-1}(x/a) + C$; $\int dx/\sqrt{a^2 - x^2} = \sin^{-1}(x/a) + C$

More special forms – $\int dx/(x^2 - a^2) = (1/2a)\ln|(x-a)/(x+a)| + C$; $\int dx/\sqrt{x^2 \pm a^2} = \ln|x + \sqrt{x^2 \pm a^2}| + C$

By parts – $\int u dv = uv - \int v du$ (choose u by ILATE)

Useful result – $\int e^x[f(x) + f'(x)]dx = e^x f(x) + C$

Definite integrals – $\int_a^b f(x)dx = \int_a^b f(a+b-x)dx$

Odd and even – $\int_{-a}^a f(x)dx = 0$ if f is odd, $2\int_0^a f(x)dx$ if f is even

How to use this sheet

- 1 Derive two results from each section once by hand, so you can rebuild them if memory fails.
- 2 Keep this sheet beside you while doing previous papers; mark every formula you had to look up.
- 3 Before the exam, rewrite the marked lines from memory on a blank page.

08 Differential equations

Linear – $dy/dx + Py = Q$; integrating factor $e^{\int P dx}$; $y \cdot IF = \int Q \cdot IF dx + C$

Homogeneous – substitute $y = vx$

Variables separable – collect x and y terms on opposite sides, then integrate

09 Vectors and 3D

Dot product – $a \cdot b = |a||b|\cos\theta = a_1b_1 + a_2b_2 + a_3b_3$

Cross product – $|a \times b| = |a||b|\sin\theta$

Projection of a on b – $(a \cdot b)/|b|$

Scalar triple product – $[a \ b \ c] = a \cdot (b \times c)$; zero if coplanar

Line – $r = a + \lambda b$; angle between lines $\cos\theta = |b_1 \cdot b_2|/(|b_1||b_2|)$

Plane (JEE Advanced) – $ax + by + cz = d$; point to plane $|ax_1 + by_1 + cz_1 - d|/\sqrt{a^2 + b^2 + c^2}$

Skew lines, shortest distance – $|(a_2 - a_1) \cdot (b_1 \times b_2)|/|b_1 \times b_2|$

Direction cosines – $l^2 + m^2 + n^2 = 1$

10 Matrices, determinants, statistics

Transpose and inverse – $(AB)^T = B^T A^T$; $A^{-1} = \text{adj}(A)/|A|$ when $|A| \neq 0$

Determinants – $|AB| = |A||B|$; $|kA| = k^n|A|$; $|\text{adj } A| = |A|^{n-1}$ ($n \times n$)

Cramer's rule – $x = D_x/D$; a unique solution when $D \neq 0$

Variance – $\sigma^2 = \Sigma(x - \bar{x})^2/n = \Sigma x^2/n - \bar{x}^2$; coefficient of variation = $(\sigma/\bar{x}) \times 100$

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