Maths Formula Sheet

Chapter by chapter, topic by topic. Written by the PadhoNa team for quick revision.

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CHAPTER 9

Trigonometric Ratios and Identities

Basic identities

PYTHAGOREAN

$$\sin^2\theta + \cos^2\theta = 1, \qquad 1 + \tan^2\theta = \sec^2\theta, \qquad 1 + \cot^2\theta = \csc^2\theta$$

ALLIED ANGLES

$$\sin(\pi - \theta) = \sin\theta,\ \cos(\pi - \theta) = -\cos\theta,\ \sin\left(\tfrac{\pi}{2} - \theta\right) = \cos\theta$$

ASTC: all ratios positive in quadrant I, sin in II, tan in III, cos in IV.

Compound angles

SINE AND COSINE

$$\sin(A \pm B) = \sin A\cos B \pm \cos A\sin B, \qquad \cos(A \pm B) = \cos A\cos B \mp \sin A\sin B$$

TANGENT

$$\tan(A \pm B) = \frac{\tan A \pm \tan B}{1 \mp \tan A\tan B}$$

PRODUCTS

$$\sin(A+B)\sin(A-B) = \sin^2 A - \sin^2 B, \qquad \cos(A+B)\cos(A-B) = \cos^2 A - \sin^2 B$$

Multiple and sub-multiple angles

DOUBLE ANGLE

$$\sin 2A = 2\sin A\cos A = \frac{2\tan A}{1+\tan^2 A}, \qquad \cos 2A = \cos^2 A - \sin^2 A = 1 - 2\sin^2 A = 2\cos^2 A - 1$$

$$\tan 2A = \frac{2\tan A}{1-\tan^2 A}, \qquad \cos 2A = \frac{1-\tan^2 A}{1+\tan^2 A}$$

TRIPLE ANGLE

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

HALF ANGLE

$$\sin^2 \frac{A}{2} = \frac{1-\cos A}{2}, \qquad \cos^2 \frac{A}{2} = \frac{1+\cos A}{2}, \qquad \tan \frac{A}{2} = \frac{1-\cos A}{\sin A}$$

Sum–product formulas

SUM TO PRODUCT

$$\sin C + \sin D = 2\sin \frac{C+D}{2}\cos \frac{C-D}{2}, \qquad \cos C + \cos D = 2\cos \frac{C+D}{2}\cos \frac{C-D}{2}$$

$$\sin C - \sin D = 2\cos \frac{C+D}{2}\sin \frac{C-D}{2}, \qquad \cos C - \cos D = -2\sin \frac{C+D}{2}\sin \frac{C-D}{2}$$

PRODUCT TO SUM

$$2\sin A\cos B = \sin(A+B) + \sin(A-B), \qquad 2\cos A\cos B = \cos(A+B) + \cos(A-B),$$

$$2\sin A\sin B = \cos(A-B) - \cos(A+B)$$

Standard results

VALUES

$$\sin 15^\circ = \frac{\sqrt{3}-1}{2\sqrt{2}}, \qquad \tan 15^\circ = 2 - \sqrt{3}, \qquad \sin 18^\circ = \frac{\sqrt{5}-1}{4}, \qquad \cos 36^\circ = \frac{\sqrt{5}+1}{4}$$

PRODUCT OF COSINES

$$\cos A\cos 2A\cos 4A\cdots\cos 2^{n-1}A = \frac{\sin 2^n A}{2^n \sin A}$$

SINES IN AP

$$\sum_{k=0}^{n-1} \sin(\alpha + k\beta) = \frac{\sin \frac{n\beta}{2}}{\sin \frac{\beta}{2}} \sin\left(\alpha + \frac{(n-1)\beta}{2}\right)$$

Same for cosines with $\cos$ in place of the last $\sin$.

THREE-ANGLE PRODUCT

$$\sin\theta\sin(60^\circ - \theta)\sin(60^\circ + \theta) = \tfrac{1}{4}\sin 3\theta$$

Conditional identities (A + B + C = π)

$$\tan A + \tan B + \tan C = \tan A\tan B\tan C$$

$$\sin 2A + \sin 2B + \sin 2C = 4\sin A\sin B\sin C$$

$$\cos A + \cos B + \cos C = 1 + 4 \sin \frac{A}{2} \sin \frac{B}{2} \sin \frac{C}{2}$$

Maximum and minimum

$$-\sqrt{a^2 + b^2} \leq a \sin \theta + b \cos \theta \leq \sqrt{a^2 + b^2}$$

$$a \sin^2 \theta + b \cos^2 \theta \in [\min(a, b),\ \max(a, b)]$$

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