# TURBO

*Created by students, for students*

## Mathematical Tools

Class 11 Physics • Complete Formula Sheet

| Sr. | Concept | Formulas | Other Information |
|---|---|---|---|
| **1. Scalars and Vectors** | | | |
| 1 | Scalar | Quantity with only magnitude | Examples: mass, temperature, time, energy |
| 2 | Vector | Quantity with both magnitude and direction | Examples: displacement, velocity, force, acceleration |
| 3 | Vector Addition | $\lvert \vec{A} + \vec{B} \rvert = \sqrt{A^2 + B^2 + 2AB\cos\theta}$ | $\theta$ = angle between vectors $\vec{A}$ and $\vec{B}$ |
| 4 | Resolution of Vector | $\vec{A} = A_x\hat{i} + A_y\hat{j}$ <br> where $A_x = A\cos\theta$, $A_y = A\sin\theta$ | $A_x$ = horizontal component <br> $A_y$ = vertical component <br> $\theta$ = angle with x-axis |
| 5 | Dot Product (Scalar Product) | $\vec{A} \cdot \vec{B} = AB\cos\theta = A_xB_x + A_yB_y + A_zB_z$ | Result is a scalar <br> $\theta$ = angle between vectors <br> If $\vec{A} \perp \vec{B}$, then $\vec{A} \cdot \vec{B} = 0$ |
| 6 | Cross Product (Vector Product) | $\lvert \vec{A} \times \vec{B} \rvert = AB\sin\theta$ <br> Direction given by right-hand rule: $\vec{A} \times \vec{B} = AB\sin\theta\,\hat{n}$ | Result is a vector <br> $\hat{n}$ = unit vector perpendicular to both $\vec{A}$ and $\vec{B}$ <br> If $\vec{A} \parallel \vec{B}$, then $\vec{A} \times \vec{B} = 0$ |
| **2. Differentiation** | | | |
| 7 | Power Rule | $\frac{d(x^n)}{dx} = nx^{n-1}$ | Valid for all real values of $n$ |
| 8 | Trigonometric Derivatives | $\frac{d(\sin x)}{dx} = \cos x$ <br> $\frac{d(\cos x)}{dx} = -\sin x$ <br> $\frac{d(\tan x)}{dx} = \sec^2 x$ | Remember: derivatives of co-functions have negative signs |
| 9 | Exponential & Logarithmic | $\frac{d(e^x)}{dx} = e^x$ <br> $\frac{d(\ln x)}{dx} = \frac{1}{x}$ | $e \approx 2.718$ (Euler's number) <br> $\ln x$ is natural logarithm (base $e$) |
| 10 | Velocity | $v = \frac{dx}{dt}$ | Velocity is rate of change of position <br> $x$ = position, $t$ = time |
| 11 | Acceleration | $a = \frac{dv}{dt} = \frac{d^2x}{dt^2}$ | Acceleration is rate of change of velocity <br> Second derivative of position |
| **3. Integration** | | | |
| 12 | Power Rule Integration | $\int x^n\,dx = \frac{x^{n+1}}{n+1} + C$ | Valid when $n \neq -1$ <br> $C$ = constant of integration |
| 13 | Reciprocal Integration | $\int \frac{1}{x}\,dx = \ln\lvert x \rvert + C$ | Special case when $n = -1$ |
| 14 | Exponential Integration | $\int e^x\,dx = e^x + C$ | Exponential function integrates to itself |

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| 15 | Trigonometric Integration | $\int \sin x \, dx = -\cos x + C$ <br> $\int \cos x \, dx = \sin x + C$ | Note the negative sign for sine integration |
| 16 | Displacement from Velocity | $\text{Displacement} = \int v \, dt$ | Area under velocity-time graph |
| 17 | Velocity from Acceleration | $\text{Velocity} = \int a \, dt$ | Area under acceleration-time graph |

### 4. Trigonometry

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| 18 | Pythagorean Identity | $\sin^2 \theta + \cos^2 \theta = 1$ | Most fundamental trigonometric identity |
| 19 | Tangent Identity | $1 + \tan^2 \theta = \sec^2 \theta$ | Derived from dividing Pythagorean identity by $\cos^2 \theta$ |
| 20 | Cotangent Identity | $1 + \cot^2 \theta = \csc^2 \theta$ | Derived from dividing Pythagorean identity by $\sin^2 \theta$ |
| 21 | Sine Addition Formula | $\sin(A \pm B) = \sin A \cos B \pm \cos A \sin B$ | Use $+$ for $(A + B)$, for $(A - B)$ |
| 22 | Cosine Addition Formula | $\cos(A \pm B) = \cos A \cos B \mp \sin A \sin B$ | Note: sign reverses () for cosine |

### 5. Coordinate Geometry

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| 23 | Distance Formula | $d = \sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2}$ | Distance between points $(x_1, y_1)$ and $(x_2, y_2)$ |
| 24 | Slope of Line | $m = \frac{y_2 - y_1}{x_2 - x_1} = \frac{\Delta y}{\Delta x}$ | Also called gradient <br> Represents rate of change |
| 25 | Equation of Line (Slope-Intercept) | $y = mx + c$ | $m = \text{slope}$ <br> $c = \text{y-intercept}$ |

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