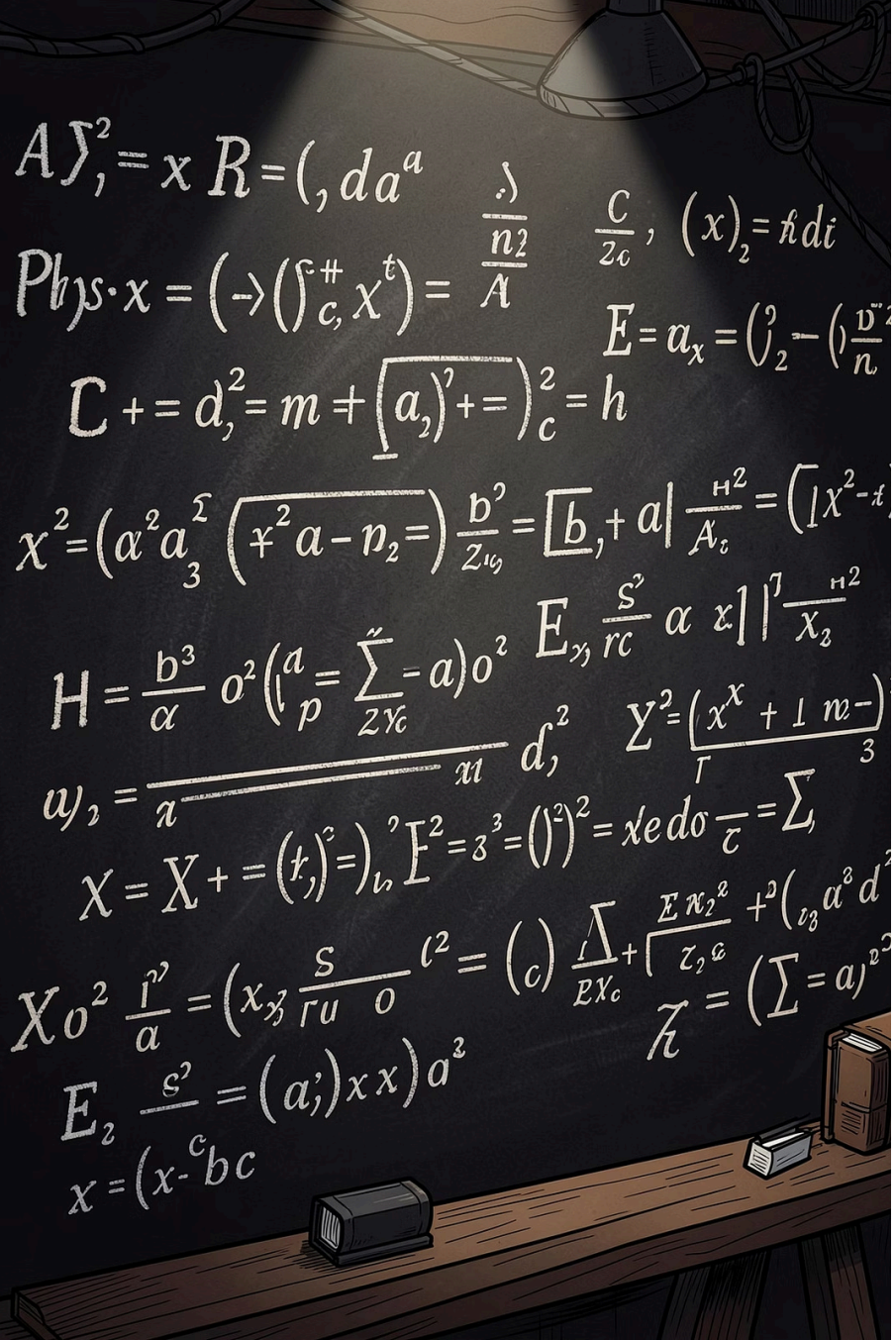


Physics Formula Mastery: The Ultimate JEE Companion

A comprehensive, chapter-by-chapter reference for Class 11 and 12 Physics — engineered for JEE Main and Advanced under the New NTA Pattern. Every formula, every concept, every shortcut you need to dominate the 99+ percentile.

CLASS 11 · CLASS 12 · JEE MAIN · JEE ADVANCED

The 2026 NTA Challenge

The New NTA Pattern has fundamentally changed how JEE Main tests Physics. Understanding this shift is the first step toward strategic preparation. The exam now rewards **formula fluency, dimensional reasoning, and rapid application** over lengthy derivations.

65%

Formula-Based Questions

Between 60–70% of JEE Main Physics questions can be solved directly through formula application and conceptual recognition.

99+

Target Percentile

Mastering high-yield topics is the primary path to a 99+ percentile under the streamlined NTA syllabus.

25

Physics Questions

JEE Main Physics section typically contains 25 questions — each demanding speed, accuracy, and conceptual clarity.

Memorization is the Foundation

Without instant recall of core formulas, even simple problems consume precious minutes. Build your formula memory first — application follows naturally.

Application is the Victory

Knowing a formula is not enough. The NTA tests your ability to identify which formula applies, under what conditions, and how to manipulate it under time pressure.

High-Yield Topics Win

With the streamlined syllabus, topics like Current Electricity, Modern Physics, and Optics carry disproportionate weight. Prioritize ruthlessly.

Core Mechanics: Building the Foundation

CLASS 11 · HIGH PRIORITY

Mechanics forms the bedrock of JEE Physics. Every subsequent chapter — from Gravitation to Electromagnetism — builds upon these principles. Mastery here is non-negotiable.

Units and Dimensions

The error-checking backbone of every calculation. Dimensional analysis can eliminate wrong options in seconds.

- Dimensional formula: $[M^a L^b T^c]$
- Principle of Homogeneity: Only like dimensions can be added
- Significant figures and error propagation: $\frac{\Delta Q}{Q} = \sqrt{\left(\frac{\Delta A}{A}\right)^2 + \left(\frac{\Delta B}{B}\right)^2}$

Kinematics — Equations of Motion

For constant acceleration along a straight line:

$$v = u + at$$

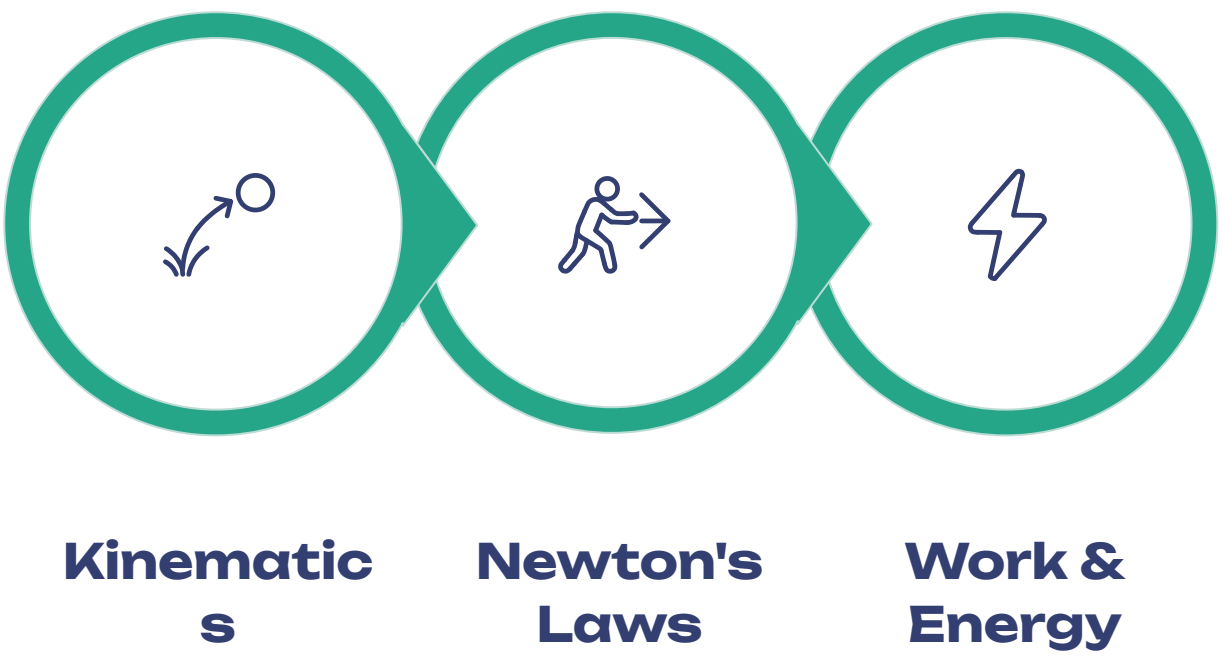
$$s = ut + \frac{1}{2}at^2$$

$$v^2 = u^2 + 2as$$

Where u = initial velocity, v = final velocity, a = acceleration, s = displacement, t = time.

Work, Power and Energy

- Work done: $W = \vec{F} \cdot \vec{s} = Fs\cos\theta$
- Kinetic Energy: $KE = \frac{1}{2}mv^2$
- Potential Energy (gravity): $PE = mgh$
- Power: $P = \frac{dW}{dt} = \vec{F} \cdot \vec{v}$
- Work-Energy Theorem: $W_{net} = \Delta KE$



These three pillars of Mechanics are deeply interconnected. Newton's Second Law $F = ma$ bridges kinematics and dynamics, while the Work-Energy Theorem provides a powerful scalar alternative to vector force analysis.

High-Impact Dynamics

CLASS 11 · ADVANCED LEVEL

These topics consistently produce the most challenging JEE Advanced problems. Understanding the geometric and physical intuition behind each formula is as important as memorization.

Projectile Motion

A particle launched with velocity u at angle θ to the horizontal:

- Time of flight: $T = \frac{2u\sin\theta}{g}$
- Maximum height: $H = \frac{u^2\sin^2\theta}{2g}$
- Horizontal range: $R = \frac{u^2\sin(2\theta)}{g}$
- Maximum range at $\theta = 45^\circ$
- Trajectory equation: $y = x\tan\theta - \frac{gx^2}{2u^2\cos^2\theta}$

Rotational Dynamics

The rotational analogues of linear motion quantities:

- Torque: $\tau = \vec{r} \times \vec{F} = I\alpha$
- Angular momentum: $L = I\omega$
- Rotational KE: $KE_{rot} = \frac{1}{2}I\omega^2$
- Moment of Inertia (disc): $I = \frac{1}{2}MR^2$
- Parallel Axis Theorem: $I = I_{cm} + Md^2$
- Perpendicular Axis Theorem: $I_z = I_x + I_y$

Your text here 2

Center of Mass and Gravitation

Center of Mass for a system of particles:

$$\vec{r}_{cm} = \frac{m_1\vec{r}_1 + m_2\vec{r}_2 + \cdots}{m_1 + m_2 + \cdots}$$

Newton's Law of Gravitation:

$$F = G\frac{m_1 m_2}{r^2}$$

- Gravitational field: $g = \frac{GM}{r^2}$
- Gravitational potential: $V = -\frac{GM}{r}$
- Orbital velocity: $v_o = \sqrt{\frac{GM}{r}}$
- Escape velocity: $v_e = \sqrt{\frac{2GM}{R}} \approx 11.2\ \text{km/s}$
- Kepler's Third Law: $T^2 \propto r^3$

Thermodynamics and Waves

CLASS 11 · CONCEPTUALLY RICH

Thermodynamics and Wave Mechanics are among the most conceptually demanding chapters. The key is understanding the physical meaning behind each law and recognizing the boundary conditions for each formula.

Kinetic Theory of Gases

- Ideal Gas Equation: $PV = nRT$
- RMS speed: $v_{rms} = \sqrt{\frac{3RT}{M}}$
- Most probable speed: $v_{mp} = \sqrt{\frac{2RT}{M}}$
- Degree of freedom: $f = 3$ (monoatomic), $f = 5$ (diatomic)
- Internal energy: $U = \frac{f}{2}nRT$

Laws of Thermodynamics

- First Law: $\Delta Q = \Delta U + \Delta W$
- Work in isothermal process: $W = nRT \ln \frac{V_2}{V_1}$
- Adiabatic relation: $PV^\gamma = \text{constant}$
- Efficiency of Carnot engine: $\eta = 1 - \frac{T_2}{T_1}$
- Coefficient of Performance (refrigerator): $COP = \frac{T_2}{T_1 - T_2}$

Simple Harmonic Motion

Restoring force: $F = -kx$

$$x = A\sin(\omega t + \phi)$$

$$v = A\omega\cos(\omega t + \phi)$$

$$T = 2\pi\sqrt{\frac{m}{k}}$$

- Angular frequency: $\omega = \sqrt{\frac{k}{m}}$
- Energy in SHM: $E = \frac{1}{2}kA^2$
- Simple Pendulum: $T = 2\pi\sqrt{\frac{l}{g}}$

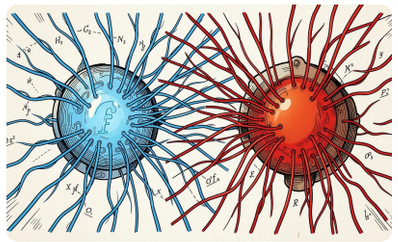
Sound Waves and Doppler Effect

- Speed of sound: $v = \sqrt{\frac{\gamma P}{\rho}}$
- Beat frequency: $f_{beat} = |f_1 - f_2|$
- Doppler Effect (source approaching): $f' = f\left(\frac{v}{v - v_s}\right)$
- Standing waves (closed pipe): $f_n = \frac{nv}{4L}$, n = 1, 3, 5...
- Standing waves (open pipe): $f_n = \frac{nv}{2L}$, n = 1, 2, 3...

The Electrodynamics Powerhouse

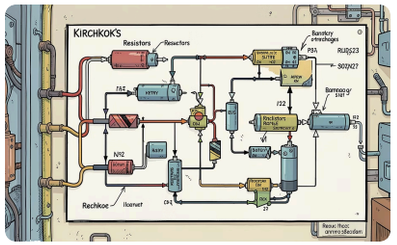
CLASS 12 · HIGHEST WEIGHTAGE

Electrodynamics — encompassing Electrostatics, Current Electricity, and Magnetism — is the single highest-weightage unit in JEE Main Physics. These three sub-topics share deep structural analogies that, once understood, dramatically reduce the memorization burden.



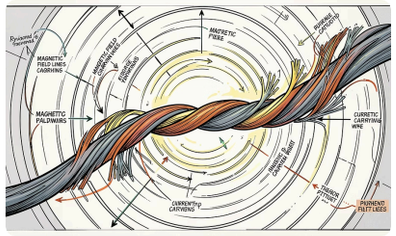
Electrostatics and Capacitance

- Coulomb's Law: $F = \frac{1}{4\pi\varepsilon_0}\frac{q_1 q_2}{r^2}$
- Electric field: $E = \frac{1}{4\pi\varepsilon_0}\frac{q}{r^2}$
- Electric potential: $V = \frac{1}{4\pi\varepsilon_0}\frac{q}{r}$
- Gauss's Law: $\oint \vec{E} \cdot d\vec{A} = \frac{q_{enc}}{\varepsilon_0}$
- Capacitance (parallel plate): $C = \frac{\varepsilon_0 A}{d}$
- Energy stored: $U = \frac{1}{2}CV^2$
- Dipole in field: $U = -\vec{p} \cdot \vec{E}$



Current Elec ity

- Ohm's Law: $V =$
- Resistance: $R = \frac{\rho l}{A}$
- Series: $R_{eq} = R_1 + R_2 + \cdots$
- Parallel: $\frac{1}{R_{eq}} = \frac{1}{R_1} + \frac{1}{R_2} + \cdots$
- Kirchhoff's Current Law (KCL): $\sum I = 0$
- Kirchhoff's Voltage Law (KVL): $\sum V = 0$
- Wheatstone Bridge balance: $\frac{R_1}{R_2} = \frac{R_3}{R_4}$
- Potentiometer: $\frac{E_1}{E_2} = \frac{l_1}{l_2}$



Magnetism and Moving Charges

- Biot-Savart Law: $dB = \frac{\mu_0}{4\pi}\frac{Idl\sin\theta}{r^2}$
- Ampere's Law: $\oint \vec{B} \cdot d\vec{l} = \mu_0 I_{enc}$
- Force on moving charge: $\vec{F} = q(\vec{v} \times \vec{B})$
- Force on current wire: $\vec{F} = I(\vec{l} \times \vec{B})$
- Cyclotron frequency: $f = \frac{qB}{2\pi m}$
- Magnetic dipole moment: $\mu = IA$
- Dipole in field: $U = -\vec{\mu} \cdot \vec{B}$

Key Analogy: Electrostatics and Magnetostatics are structurally identical. Replace $q \to \mu$, $E \to B$, and $\varepsilon_0 \to 1/\mu_0$ to translate between the two domains. This saves significant memorization effort.

Modern Physics and Optics

CLASS 12 · HIGH SCORING

Modern Physics and Optics are among the most formula-dense yet high-scoring chapters. Questions from these topics are typically direct and formula-based, making them ideal for quick score accumulation under exam conditions.

Geometrical Optics

- Mirror formula: $\frac{1}{f} = \frac{1}{v} + \frac{1}{u}$
- Magnification: $m = -\frac{v}{u} = \frac{h_i}{h_o}$
- Lens formula: $\frac{1}{f} = \frac{1}{v} - \frac{1}{u}$
- Lens maker's formula: $\frac{1}{f} = (\mu - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$
- Power of lens: $P = \frac{1}{f(\text{in m})}$ (in Diopters)
- Combination of lenses: $P = P_1 + P_2$

Wave Optics

- Young's Double Slit — fringe width: $\beta = \frac{\lambda D}{d}$
- Constructive: $d\sin\theta = n\lambda$
- Destructive: $d\sin\theta = (n + \frac{1}{2})\lambda$
- Single slit minima: $a\sin\theta = n\lambda$
- Resolving power (microscope): $RP = \frac{2\mu\sin\theta}{\lambda}$

Dual Nature of Matter and Radiation

- Photoelectric equation: $K_{max} = h\nu - \phi$
- Threshold frequency: $\nu_0 = \frac{\phi}{h}$
- De Broglie wavelength: $\lambda = \frac{h}{p} = \frac{h}{mv}$
- For electron: $\lambda = \frac{12.27}{\sqrt{V}}\ \text{Å}$
- Photon energy: $E = h\nu = \frac{hc}{\lambda}$
- Photon momentum: $p = \frac{h}{\lambda}$

Atomic Structure and Radioactivity

- Bohr radius: $r_n = 0.529\frac{n^2}{Z}\ \text{Å}$
- Energy of nth orbit: $E_n = -13.6\frac{Z^2}{n^2}\ \text{eV}$
- Rydberg formula: $\frac{1}{\lambda} = R\left(\frac{1}{n_1^2} - \frac{1}{n_2^2}\right)$
- Radioactive decay: $N = N_0 e^{-\lambda t}$
- Half-life: $T_{1/2} = \frac{0.693}{\lambda}$
- Mass-energy equivalence: $E = \Delta m \cdot c^2$

Semiconductor Electronics

- Current gain (CE): $\beta = \frac{\Delta I_C}{\Delta I_B}$
- Relation: $\beta = \frac{\alpha}{1-\alpha}$
- Logic gates: AND, OR, NOT, NAND, NOR truth tables

The Strategy of Analogy: Learning Smarter

EXAM STRATEGY

The most efficient JEE aspirants don't just memorize — they **connect**. Analogical reasoning reduces the cognitive load of 200+ formulas to a handful of core principles. Dimensional analysis serves as your final safety net against negative marking.

Electrostatics ↔️ Magnetostatics

The potential energy of a dipole in an electric field is $U = -\vec{p} \cdot \vec{E}$. By analogy, the potential energy of a magnetic dipole in a magnetic field is $U = -\vec{\mu} \cdot \vec{B}$. This single analogy covers torque, energy, and equilibrium conditions for both domains simultaneously.

SHM ↔️ Uniform Circular Motion

Simple Harmonic Motion is the projection of uniform circular motion onto a diameter. This connection explains why $x = A\cos(\omega t)$ and why the velocity leads displacement by 90°. Use this to derive all SHM formulas from circular motion principles.

Dimensional Analysis: The Final Check

Before marking any answer, verify dimensions. For example, if the question asks for time and your expression has dimensions $[M^0 L^0 T^{-1}]$, you've inverted the formula. Common checks:

- Energy: $[ML^2T^{-2}]$
- Force: $[MLT^{-2}]$
- Momentum: $[MLT^{-1}]$
- Potential: $[ML^2T^{-3}A^{-1}]$

Memorize These Constants Precisely

Calculation drift under exam pressure is a silent score-killer. Know these values cold:

- $g = 9.8 \approx 10\ \text{m/s}^2$
- $h = 6.63 \times 10^{-34}\ \text{J·s}$
- $e = 1.6 \times 10^{-19}\ \text{C}$
- $k = 1.38 \times 10^{-23}\ \text{J/K}$
- $\varepsilon_0 = 8.85 \times 10^{-12}\ \text{F/m}$
- $\mu_0 = 4\pi \times 10^{-7}\ \text{T·m/A}$
- $c = 3 \times 10^8\ \text{m/s}$

⚠ **Pro Tip:** When stuck between options, eliminate those with wrong dimensions first. In many NTA papers, this alone narrows choices to 1–2 options, dramatically improving your guess accuracy.

Operational Implementation: Your Study System

EXECUTION PLAN

A formula book is only as powerful as the system built around it. Transform this resource from a passive reference into an active learning engine with daily practice, iterative annotation, and strategic shortcut identification.

01

Daily Formula Recall (15 min)

Begin each study session with a 15-minute formula recall drill. Pick one chapter, write all formulas from memory, then verify against this book. Mark any gaps in red. This spaced repetition technique is scientifically proven to move formulas from short-term to long-term memory.

02

Previous Year NTA Paper Integration

After studying a chapter, immediately solve 10–15 previous year NTA questions from that topic. Tag each question in your notebook with the specific formula(s) used. This builds the critical skill of *formula identification under problem conditions* — the actual skill JEE tests.

03

Iterative Annotation: Make It Living

This formula book should accumulate your personal annotations over time. Add: (a) shortcuts you discover, (b) common traps you've fallen into, (c) NTA question patterns you notice, and (d) cross-chapter connections. A heavily annotated formula book in the last 30 days before the exam is worth more than any fresh textbook.

04

Derivative Shortcuts for Speed

Identify and memorize high-frequency derivative results: e.g., maximum range at 45°, maximum power transfer when $R = r$, condition for interference maxima/minima. These "ready results" save 30–60 seconds per question — critical in a 3-hour paper with 75 questions.

05

Weekly Mock Test + Formula Audit

After each weekly mock test, perform a "formula audit": for every incorrect or guessed question, identify which formula was missing or misapplied. Add this to your annotation system. This closes the loop between performance gaps and targeted formula revision.

⚡ Rapid Revision Protocol

In the last 30 days before JEE Main:

- Day 1–10: Mechanics + Thermodynamics
- Day 11–20: Electrodynamics + Optics
- Day 21–27: Modern Physics + Semiconductors
- Day 28–30: Full formula book sweep

📊 Topic Weightage Priority

Based on NTA trends (2021–2024):

1. Current Electricity — ~4 questions/year
2. Modern Physics — ~3–4 questions/year
3. Electrostatics + Magnetism — ~3 questions/year
4. Optics — ~2–3 questions/year
5. SHM + Waves — ~2 questions/year
6. Rotational Motion — ~1–2 questions/year

Your Path to Success: The Final Sprint

You now hold a comprehensive map of every formula, concept, and strategy required to excel in JEE Main and Advanced Physics. The difference between a 70 percentile and a 99+ percentile is not intelligence — it is **systematic execution**.

Focus on High-Weightage Topics

Prioritize Current Electricity, Modern Physics, Electrostatics, and Optics. These four topics alone account for nearly 50% of all Physics questions in recent NTA papers. Master them first, then expand.

Master the Formula First

Before attempting a single problem from a new chapter, spend 30 minutes writing and understanding every formula. Know the conditions of validity, the units, and the physical meaning. Formula-first preparation eliminates confusion during problem-solving.

Accuracy Before Speed

In the early stages of preparation, prioritize accuracy over speed. A correct answer in 5 minutes is worth infinitely more than a wrong answer in 2 minutes. Speed develops naturally through repetition — accuracy must be built deliberately.

Start Your Final Sprint Today

Every day of delayed preparation is a day of compounding disadvantage. Begin with one chapter today. Write the formulas. Solve five problems. Annotate your book. Repeat tomorrow. Consistency, not intensity, produces 99+ percentilers.

> **"The exam doesn't test how much you know — it tests how quickly and accurately you can apply what you know."** Build your formula memory, sharpen your problem recognition, and trust your preparation. Your 99+ percentile is not a dream — it is a plan executed with discipline.

200+

Formulas Covered

Every key formula from Class 11 and 12 Physics, organized by chapter and priority.

15

Core Chapters

From Units and Dimensions to Semiconductor Electronics — complete syllabus coverage.

1

Goal

Your 99+ percentile. Start today. Stay consistent. Win decisively.