Durgesh Physics Classes

Complete Physics Study Notes for NEET & JEE Preparation

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Mechanics

1. Kinematics

Key Concepts:

- Motion in one, two, and three dimensions
- Displacement, velocity, and acceleration
- Relative motion

Important Equations:

- $v = u + at$
- $s = ut + \frac{1}{2}at^2$
- $v^2 = u^2 + 2as$
- $s = (u + v)t/2$

Projectile Motion:

- Horizontal range: $R = u^2\sin(2\theta)/g$
- Maximum height: $H = u^2\sin^2\theta/2g$

- Time of flight: $T = 2u\sin\theta/g$

Key Points for Exams:

- Always draw proper free body diagrams
- Identify given and required quantities clearly
- Use appropriate kinematic equations
- Pay attention to signs and directions

2. Laws of Motion

Newton's Laws:

1. **First Law:** Object at rest stays at rest, object in motion stays in motion unless acted upon by external force
2. **Second Law:** $F = ma$
3. **Third Law:** Every action has equal and opposite reaction

Friction:

- Static friction: $f_s \leq \mu_s N$
- Kinetic friction: $f_k = \mu_k N$
- Always opposing relative motion

Circular Motion:

- Centripetal force: $F_c = mv^2/r = m\omega^2 r$
- Centripetal acceleration: $a_c = v^2/r = \omega^2 r$

3. Work, Energy, and Power

Work: $W = F \cdot s \cdot \cos\theta$ **Kinetic Energy:** $KE = \frac{1}{2}mv^2$ **Potential Energy:** $PE = mgh$ (gravitational) **Conservation of Energy:** $KE_1 + PE_1 = KE_2 + PE_2$ **Power:** $P = W/t = F \cdot v$

Work-Energy Theorem: Net work done = Change in kinetic energy

4. Rotational Motion

Angular displacement: θ (radians) **Angular velocity:** $\omega = d\theta/dt$ **Angular acceleration:** $\alpha = d\omega/dt$

Moment of Inertia:

- Point mass: $I = mr^2$
- Rod (center): $I = ML^2/12$
- Rod (end): $I = ML^2/3$

- Disk: $I = MR^2/2$
- Sphere: $I = 2MR^2/5$

Rotational Kinetic Energy: $KE_{rot} = \frac{1}{2}I\omega^2$ **Torque:** $\tau = rF\sin\theta = I\alpha$

Thermodynamics

1. Kinetic Theory of Gases

Ideal Gas Equation: $PV = nRT = NkT$ **Kinetic Energy:** Average $KE = (3/2)kT$ **RMS Speed:** $v_{rms} = \sqrt{(3RT/M)} = \sqrt{(3kT/m)}$

Maxwell-Boltzmann Distribution:

- Most probable speed: $v_{mp} = \sqrt{(2RT/M)}$
- Average speed: $v_{avg} = \sqrt{(8RT/\pi M)}$

2. Laws of Thermodynamics

Zeroth Law: Thermal equilibrium is transitive **First Law:** $\Delta U = Q - W$ (Energy conservation) **Second Law:** Entropy of isolated system never decreases **Third Law:** Entropy approaches zero at absolute zero

Thermodynamic Processes:

- **Isothermal:** $\Delta T = 0$, $\Delta U = 0$, $Q = W = nRT \ln(V_f/V_i)$
- **Adiabatic:** $Q = 0$, $W = -\Delta U = -nC_v\Delta T$
- **Isobaric:** $\Delta P = 0$, $W = P\Delta V$
- **Isochoric:** $\Delta V = 0$, $W = 0$, $Q = \Delta U$

Heat Engines:

- Efficiency: $\eta = W/Q_h = 1 - Q_c/Q_h$
- Carnot efficiency: $\eta_c = 1 - T_c/T_h$

Waves and Oscillations

1. Simple Harmonic Motion (SHM)

Equation: $x = A \sin(\omega t + \varphi)$ **Velocity:** $v = A\omega \cos(\omega t + \varphi)$ **Acceleration:** $a = -A\omega^2 \sin(\omega t + \varphi) = -\omega^2 x$

Energy in SHM:

- Total energy: $E = \frac{1}{2}m\omega^2A^2$
- Kinetic energy: $KE = \frac{1}{2}m\omega^2(A^2 - x^2)$
- Potential energy: $PE = \frac{1}{2}m\omega^2x^2$

Common SHM Systems:

- Spring-mass: $T = 2\pi\sqrt{(m/k)}$
- Simple pendulum: $T = 2\pi\sqrt{(l/g)}$
- Physical pendulum: $T = 2\pi\sqrt{(I/mgd)}$

2. Wave Motion

Wave Equation: $y = A \sin(kx - \omega t + \varphi)$ **Wave speed:** $v = f\lambda = \omega/k$ **Wave number:** $k = 2\pi/\lambda$ **Angular frequency:** $\omega = 2\pi f$

Types of Waves:

- **Transverse:** Particle motion perpendicular to wave direction
- **Longitudinal:** Particle motion parallel to wave direction

Standing Waves:

- Nodes: Points of zero amplitude
- Antinodes: Points of maximum amplitude
- Distance between adjacent nodes = $\lambda/2$

Electromagnetism

1. Electrostatics

Coulomb's Law: $F = kq_1q_2/r^2 = q_1q_2/(4\pi\varepsilon_0r^2)$ **Electric Field:** $E = F/q = kQ/r^2$ **Electric Potential:** $V = kQ/r$ **Relation:** $E = -dV/dr$

Gauss's Law: $\oint E \cdot dA = Q_{enc}/\varepsilon_0$

Capacitance:

- Parallel plate capacitor: $C = \varepsilon_0A/d$
- Energy stored: $U = \frac{1}{2}CV^2 = \frac{1}{2}QV = Q^2/2C$

- Series: $1/C_{eq} = 1/C_1 + 1/C_2 + ...$
- Parallel: $C_{eq} = C_1 + C_2 + ...$

2. Current Electricity

Ohm's Law: $V = IR$ **Resistance:** $R = \rho l/A$ **Power:** $P = VI = I^2R = V^2/R$

Kirchhoff's Laws:

- **Current Law (KCL):** Sum of currents at a junction = 0
- **Voltage Law (KVL):** Sum of voltage drops in a loop = 0

Series Resistance: $R_{eq} = R_1 + R_2 + R_3 + ...$ **Parallel Resistance:** $1/R_{eq} = 1/R_1 + 1/R_2 + 1/R_3 + ...$

3. Magnetism

Magnetic Force:

- On moving charge: $F = qvB \sin\theta$
- On current-carrying conductor: $F = BIl \sin\theta$

Biot-Savart Law: $dB = (\mu_0/4\pi) \times (Idl \times r)/r^3$

Ampere's Law: $\oint B \cdot dl = \mu_0 I_{enc}$

Magnetic Field:

- Straight wire: $B = \mu_0 I/(2\pi r)$
- Center of circular loop: $B = \mu_0 I/(2R)$
- Solenoid: $B = \mu_0 nI$

4. Electromagnetic Induction

Faraday's Law: $\varepsilon = -d\Phi/dt$ **Lenz's Law:** Induced current opposes the change causing it
Motional EMF: $\varepsilon = Blv$

Self-Inductance: $\varepsilon = -L(dI/dt)$ **Energy in Inductor:** $U = \frac{1}{2}LI^2$

AC Circuits:

- RMS values: $V_{rms} = V_0/\sqrt{2}$, $I_{rms} = I_0/\sqrt{2}$
- Power: $P = V_{rms}I_{rms} \cos\varphi$
- Reactances: $X_L = \omega L$, $X_C = 1/(\omega C)$
- Impedance: $Z = \sqrt{(R^2 + (X_L - X_C)^2)}$

Optics

1. Geometric Optics

Reflection:

- Law: Angle of incidence = Angle of reflection
- Mirror equation: $1/f = 1/u + 1/v$
- Magnification: $m = -v/u = h'/h$

Refraction:

- Snell's Law: $n_1 \sin\theta_1 = n_2 \sin\theta_2$
- Critical angle: $\sin\theta c = n_2/n_1$ ($n_1 > n_2$)
- Lens equation: $1/f = 1/u + 1/v$
- Lens maker's formula: $1/f = (n-1)(1/R_1 - 1/R_2)$

2. Wave Optics

Interference:

- Constructive: Path difference = $n\lambda$
- Destructive: Path difference = $(n + ½)\lambda$
- Young's double slit: $\beta = \lambda D/d$

Diffraction:

- Single slit: $a \sin\theta = n\lambda$ (minima)
- Rayleigh criterion: $\theta = 1.22\lambda/D$

Polarization:

- Malus's Law: $I = I_0 \cos^2\theta$
- Brewster's angle: $\tan\theta B = n$

Modern Physics

1. Photoelectric Effect

Einstein's Equation: $hf = \varphi + KE_{max}$ **Stopping potential:** $eV_0 = KE_{max} = hf - \varphi$ **Threshold frequency:** $f_0 = \varphi/h$

2. Atomic Structure

Bohr's Model:

- Angular momentum: $mvr = nh/2\pi$
- Energy levels: $E_n = -13.6/n^2$ eV (for hydrogen)
- Rydberg formula: $1/\lambda = R(1/n_1^2 - 1/n_2^2)$

3. Nuclear Physics

Mass-Energy Relation: $E = mc^2$ **Radioactive decay:** $N = N_0e^{(-\lambda t)}$ **Half-life:** $t_{1/2} = \ln 2/\lambda = 0.693/\lambda$

Important Formulas Summary

Mechanics

- $v^2 = u^2 + 2as$
- $F = ma$
- $W = F \cdot s \cdot \cos\theta$
- $KE = \frac{1}{2}mv^2$
- $PE = mgh$
- $\tau = I\alpha$

Thermodynamics

- $PV = nRT$
- $\Delta U = Q - W$
- $\eta = 1 - Tc/Th$ (Carnot)

Waves

- $v = f\lambda$
- $T = 2\pi\sqrt{(m/k)}$
- $T = 2\pi\sqrt{(l/g)}$

Electricity

- $V = IR$

- $P = VI = I^2R$
- $C = Q/V$
- $F = kq_1q_2/r^2$

Magnetism

- $F = qvB \sin\theta$
- $B = \mu_0 I/(2\pi r)$
- $\varepsilon = -d\Phi/dt$

Optics

- $1/f = 1/u + 1/v$
- $n_1 \sin\theta_1 = n_2 \sin\theta_2$
- $\beta = \lambda D/d$

Modern Physics

- $E = hf$
- $E = mc^2$
- $En = -13.6/n^2$ eV

Problem-Solving Strategies

General Approach:

1. **Read carefully** - Understand what's given and what's asked
2. **Draw diagrams** - Visual representation helps
3. **Identify concepts** - Which physics principles apply?
4. **List known values** - Organize given information
5. **Choose appropriate formula** - Select relevant equations
6. **Solve systematically** - Step-by-step calculation
7. **Check units** - Ensure dimensional consistency
8. **Verify answer** - Does it make physical sense?

Common Mistakes to Avoid:

- Not drawing free body diagrams
- Mixing up signs and directions
- Using wrong formulas
- Calculation errors
- Not checking units

- Rushing through problems

Time Management Tips:

- Attempt easy questions first
- Don't spend too much time on one problem
- Practice speed with accuracy
- Review and revise regularly
- Solve previous year papers

Important Topics by Weightage:

NEET High Priority:

- Mechanics (25-30%)
- Thermodynamics (10-12%)
- Waves and Sound (8-10%)
- Electricity (15-18%)
- Optics (10-12%)
- Modern Physics (12-15%)

JEE Main High Priority:

- Mechanics (30-35%)
- Electricity and Magnetism (20-25%)
- Thermodynamics (8-10%)
- Waves (8-10%)
- Modern Physics (10-12%)
- Optics (8-10%)

Exam Day Tips:

- Get adequate sleep before exam
- Reach exam center early
- Read questions carefully
- Manage time effectively
- Stay calm and confident
- Review answers if time permits

Best of luck with your NEET and JEE preparation!

Prepared by Durgesh Physics Classes For additional practice problems and detailed solutions, consult standard physics textbooks and previous year question papers.