Physics Formula Sheet

Mitochondria

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Physics Chapter-wise Formulas - Class 11 & 12 (CBSE 2025-26)

Class 11 Chapters

Class 12 Chapters

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2. Electrostatic Potential and Capacitance
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4. Moving Charges and Magnetism
5. Magnetism and Matter
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Class 11 Physics Formulas

Chapter 1 - Physical World and Units and Measurements

Fundamental Physical Constants:

- Speed of light: $c = 3 \times 10^8$ m/s
- Planck's constant: $h = 6.63 \times 10^{-34}$ J·s
- Gravitational constant: $G = 6.67 \times 10^{-11}$ $m^3 \cdot kg^{-1} \cdot s^{-2}$
- Avogadro's number: $N_A = 6.023 \times 10^{23}$ mol^{-1}
- Boltzmann constant: $k = 1.38 \times 10^{-23}$ J/K

Dimensional Analysis:

- $[M^a L^b T^c] = [M^x L^y T^z]$
- For dimensionally correct equations: $a = x, b = y, c = z$

Chapter 2-3 - Kinematics (Motion in Straight Line & Motion in Plane)

Equations of Motion (Uniform Acceleration):

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

Free Fall Motion:

- $v = gt$ (taking downward as positive)
- $h = \frac{1}{2}gt^2$
- $v^2 = 2gh$

Projectile Motion:

- Time of flight: $T = \frac{2u \sin\theta}{g}$
- Maximum height: $H = \frac{u^2 \sin^2\theta}{2g}$
- Range: $R = \frac{u^2 \sin 2\theta}{g}$
- Trajectory equation: $y = x\tan\theta - \frac{gx^2}{2u^2\cos^2\theta}$

Relative Motion:

- $\vec{v}_{AB} = \vec{v}_A - \vec{v}_B$
- $\vec{a}_{AB} = \vec{a}_A - \vec{a}_B$

Chapter 4 - Laws of Motion

Newton's Laws:

- First Law: $\vec{F}_{\text{net}} = 0 \Rightarrow \vec{a} = 0$
- Second Law: $\vec{F} = m\vec{a} = \frac{d\vec{p}}{dt}$
- Third Law: $\vec{F}_{AB} = -\vec{F}_{BA}$

Friction:

- Static friction: $f_s \leq \mu_s N$
- Kinetic friction: $f_k = \mu_k N$

Spring Force:

- $F = -kx$ (Hooke's Law)

Chapter 5 - Work, Energy and Power

Work:

- $W = \vec{F} \cdot \vec{s} = Fs\cos\theta$
- $W = \int \vec{F} \cdot d\vec{s}$ (variable force)

Kinetic Energy:

- $K = \frac{1}{2}mv^2$
- Work-Energy Theorem: $W_{\text{net}} = \Delta K$

Potential Energy:

- Gravitational: $U = mgh$
- Elastic: $U = \frac{1}{2}kx^2$

Power:

- $P = \frac{W}{t} = \vec{F} \cdot \vec{v}$

Conservation of Energy:

- $E = K + U = \text{constant}$ (conservative forces)

Chapter 6 - System of Particles and Rotational Motion

Center of Mass:

- $\vec{r}_{cm} = \frac{\sum m_i \vec{r}_i}{\sum m_i}$
- $\vec{v}_{cm} = \frac{\sum m_i \vec{v}_i}{M}$

Angular Motion:

- $\omega = \frac{d\theta}{dt}$
- $\alpha = \frac{d\omega}{dt}$
- $v = r\omega$
- $a_t = r\alpha$
- $a_c = r\omega^2$

Moment of Inertia:

- Point mass: $I = mr^2$
- Solid sphere: $I = \frac{2}{5}MR^2$
- Hollow sphere: $I = \frac{2}{3}MR^2$
- Solid cylinder: $I = \frac{1}{2}MR^2$
- Hollow cylinder: $I = MR^2$
- Rod (about center): $I = \frac{1}{12}ML^2$

Parallel Axis Theorem:

- $I = I_{cm} + Md^2$

Rotational Dynamics:

- $\tau = I\alpha$
- $\tau = \vec{r} \times \vec{F}$
- Rotational KE: $K_{\text{rot}} = \frac{1}{2}I\omega^2$

Angular Momentum:

- $\vec{L} = I\vec{\omega} = \vec{r} \times \vec{p}$
- Conservation: $\vec{L} = \text{constant}$ (when $\tau_{\text{ext}} = 0$)

Chapter 7 - Gravitation

Universal Law of Gravitation:

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

Gravitational Field:

- $\vec{g} = \frac{\vec{F}}{m} = -G\frac{M}{r^2}\hat{r}$

Gravitational Potential:

- $V = -\frac{GM}{r}$
- $U = -\frac{GMm}{r}$

Escape Velocity:

- $v_e = \sqrt{\frac{2GM}{R}} = \sqrt{2gR}$

Orbital Velocity:

- $v_0 = \sqrt{\frac{GM}{r}}$

Satellite Motion:

- Time period: $T = 2\pi\sqrt{\frac{r^3}{GM}}$

Chapter 8-10 - Properties of Bulk Matter

Elasticity:

- Stress = $\frac{F}{A}$
- Strain = $\frac{\Delta L}{L}$
- Young's modulus: $Y = \frac{\text{Stress}}{\text{Strain}}$
- Bulk modulus: $B = -\frac{\Delta P}{\Delta V/V}$
- Shear modulus: $\eta = \frac{\text{Shear stress}}{\text{Shear strain}}$

Surface Tension:

- $\gamma = \frac{F}{l}$
- Excess pressure in soap bubble: $\Delta P = \frac{4\gamma}{R}$
- Excess pressure in drop: $\Delta P = \frac{2\gamma}{R}$

Fluid Mechanics:

- Pascal's Law: $P_1 = P_2$ (same level)
- Archimedes' Principle: $F_b = \rho_{\text{fluid}} V_{\text{displaced}} g$
- Bernoulli's Equation: $P + \frac{1}{2}\rho v^2 + \rho g h = \text{constant}$

Thermal Expansion:

- Linear: $L = L_0(1 + \alpha \Delta T)$
- Area: $A = A_0(1 + \beta \Delta T)$, where $\beta = 2\alpha$
- Volume: $V = V_0(1 + \gamma \Delta T)$, where $\gamma = 3\alpha$

Chapter 11 - Thermodynamics

First Law of Thermodynamics:

- $\Delta U = Q - W$

Work Done by Gas:

- Isobaric: $W = P\Delta V$
- Isothermal: $W = nRT \ln\left(\frac{V_f}{V_i}\right)$
- Adiabatic: $W = \frac{nR(T_i - T_f)}{\gamma - 1}$

Heat Capacities:

- $C_v = \frac{f}{2}R$
- $C_p = C_v + R$
- $\gamma = \frac{C_p}{C_v}$

Adiabatic Process:

- $PV^{\gamma} = \text{constant}$
- $TV^{\gamma-1} = \text{constant}$
- $P^{1-\gamma}T^{\gamma} = \text{constant}$

Heat Engine Efficiency:

- $\eta = 1 - \frac{T_C}{T_H}$ (Carnot engine)

Chapter 12 - Kinetic Theory of Gases

Kinetic Theory:

- $PV = \frac{1}{3}Nm\langle v^2 \rangle$
- $\langle v^2 \rangle = \frac{3kT}{m}$

RMS Speed:

- $v_{\text{rms}} = \sqrt{\frac{3kT}{m}} = \sqrt{\frac{3RT}{M}}$

Mean Speed:

- $\langle v \rangle = \sqrt{\frac{8kT}{\pi m}}$

Most Probable Speed:

- $v_{\text{mp}} = \sqrt{\frac{2kT}{m}}$

Degrees of Freedom:

- Monatomic: f = 3
- Diatomic: f = 5
- Polyatomic: f = 6

Chapter 13-14 - Oscillations and Waves

Simple Harmonic Motion:

- $F = -kx$
- $x = A\sin(\omega t + \phi)$
- $\omega = \sqrt{\frac{k}{m}}$
- $T = 2\pi\sqrt{\frac{m}{k}}$

Energy in SHM:

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

Simple Pendulum:

- $T = 2\pi\sqrt{\frac{l}{g}}$

Wave Motion:

- $v = f\lambda$
- Wave equation: $y = A\sin(\omega t - kx + \phi)$
- Wave number: $k = \frac{2\pi}{\lambda}$

Speed of Sound:

- In gas: $v = \sqrt{\frac{\gamma P}{\rho}} = \sqrt{\frac{\gamma RT}{M}}$
- In solid: $v = \sqrt{\frac{Y}{\rho}}$

Class 12 Physics Formulas

Chapter 1 - Electric Charges and Fields

Coulomb's Law:

- $F = k\frac{q_1 q_2}{r^2} = \frac{1}{4\pi\varepsilon_0}\frac{q_1 q_2}{r^2}$
- $k = 9 \times 10^9$ N·m²/C²

Electric Field:

- $\vec{E} = \frac{\vec{F}}{q_0}$
- Point charge: $E = k\frac{q}{r^2}$
- Electric dipole (axial): $E = \frac{2kp}{r^3}$
- Electric dipole (equatorial): $E = \frac{kp}{r^3}$

Electric Flux:

- $\Phi = \vec{E} \cdot \vec{A} = EA\cos\theta$

Gauss's Law:

- $\Phi = \frac{q_{\text{enc}}}{\varepsilon_0}$

Electric Field of Various Distributions:

- Infinite line charge: $E = \frac{\lambda}{2\pi\varepsilon_0 r}$
- Infinite plane sheet: $E = \frac{\sigma}{2\varepsilon_0}$
- Spherical shell: $E = \frac{kQ}{r^2}$ (r > R), $E = 0$ (r < R)

Chapter 2 - Electrostatic Potential and Capacitance

Electric Potential:

- $V = \frac{W}{q_0} = k\frac{q}{r}$
- $V = -\int \vec{E} \cdot d\vec{l}$

Potential Energy:

- $U = qV$
- System of charges: $U = \frac{1}{2}\sum q_i V_i$

Capacitance:

- $C = \frac{Q}{V}$
- Parallel plate: $C = \frac{\varepsilon_0 A}{d}$
- Spherical: $C = 4\pi\varepsilon_0 R$

Energy Stored:

- $U = \frac{1}{2}CV^2 = \frac{1}{2}QV = \frac{Q^2}{2C}$

Combination of Capacitors:

- Series: $\frac{1}{C_{\text{eq}}} = \frac{1}{C_1} + \frac{1}{C_2} + \cdots$
- Parallel: $C_{\text{eq}} = C_1 + C_2 + \cdots$

Dielectrics:

- $C = KC_0$ where K is dielectric constant

Chapter 3 - Current Electricity

Current:

- $I = \frac{Q}{t} = \frac{dQ}{dt}$
- $I = nAve$ (drift velocity)

Ohm's Law:

- $V = IR$
- $R = \rho \frac{l}{A}$

Resistivity and Temperature:

- $\rho = \rho_0[1 + \alpha(T - T_0)]$

Power:

- $P = VI = I^2R = \frac{V^2}{R}$

Combination of Resistors:

- Series: $R_{\text{eq}} = R_1 + R_2 + \cdots$
- Parallel: $\frac{1}{R_{\text{eq}}} = \frac{1}{R_1} + \frac{1}{R_2} + \cdots$

Kirchhoff's Laws:

- Current Law: $\sum I_{\text{in}} = \sum I_{\text{out}}$
- Voltage Law: $\sum \varepsilon = \sum IR$

Wheatstone Bridge:

- Balance condition: $\frac{P}{Q} = \frac{R}{S}$

Chapter 4 - Moving Charges and Magnetism

Magnetic Force:

- On charge: $\vec{F} = q(\vec{v} \times \vec{B})$
- On current: $\vec{F} = I\vec{l} \times \vec{B}$

Biot-Savart Law:

- $d\vec{B} = \frac{\mu_0}{4\pi} \frac{Id\vec{l} \times \vec{r}}{r^3}$

Magnetic Field:

- Straight wire: $B = \frac{\mu_0 I}{2\pi r}$
- Circular loop (center): $B = \frac{\mu_0 I}{2R}$
- Solenoid: $B = \mu_0 n I$

Force Between Parallel Wires:

- $F = \frac{\mu_0 I_1 I_2 l}{2\pi r}$

Torque on Current Loop:

- $\tau = BINA \sin\theta = \vec{M} \times \vec{B}$
- Magnetic moment: $\vec{M} = NIA\hat{n}$

Chapter 5 - Magnetism and Matter

Magnetic Intensity:

- $\vec{H} = \frac{\vec{B}}{\mu_0} - \vec{M}$

Magnetization:

- $\vec{M} = \chi \vec{H}$

Permeability:

- $\mu = \mu_0(1 + \chi) = \mu_0 \mu_r$

Classification:

- Diamagnetic: $\chi < 0, \mu_r < 1$
- Paramagnetic: $\chi > 0, \mu_r > 1$
- Ferromagnetic: $\chi \gg 0, \mu_r \gg 1$

Chapter 6 - Electromagnetic Induction

Faraday's Law:

- $\varepsilon = -\frac{d\Phi}{dt}$
- $\Phi = BA\cos\theta$

Lenz's Law:

- Induced current opposes the change in flux

Motional EMF:

- $\varepsilon = Blv$

Self-Inductance:

- $\varepsilon = -L\frac{dI}{dt}$
- Solenoid: $L = \mu_0 n^2 Al$

Mutual Inductance:

- $\varepsilon_2 = -M\frac{dI_1}{dt}$

Energy in Inductor:

- $U = \frac{1}{2}LI^2$

Chapter 7 - Alternating Current

AC Voltage and Current:

- $V = V_0 \sin \omega t$
- $I = I_0 \sin(\omega t + \phi)$

RMS Values:

- $V_{\text{rms}} = \frac{V_0}{\sqrt{2}}$
- $I_{\text{rms}} = \frac{I_0}{\sqrt{2}}$

Reactance:

- Inductive: $X_L = \omega L$
- Capacitive: $X_C = \frac{1}{\omega C}$

Impedance:

- $Z = \sqrt{R^2 + (X_L - X_C)^2}$

Power:

- $P = V_{\text{rms}} I_{\text{rms}} \cos \phi$
- Power factor: $\cos \phi = \frac{R}{Z}$

Resonance:

- $\omega_0 = \frac{1}{\sqrt{LC}}$

Transformer:

- $\frac{V_s}{V_p} = \frac{N_s}{N_p} = \frac{I_p}{I_s}$

Chapter 8 - Electromagnetic Waves

Wave Equation:

- $c = \frac{1}{\sqrt{\mu_0 \varepsilon_0}}$

Properties:

- $E = cB$
- $c = 3 \times 10^8$ m/s

Energy Density:

- $u = \frac{1}{2}\varepsilon_0 E^2 + \frac{1}{2\mu_0} B^2$

Poynting Vector:

- $\vec{S} = \frac{1}{\mu_0}(\vec{E} \times \vec{B})$

Chapter 9 - Ray Optics and Optical Instruments

Laws of Reflection:

- $\theta_i = \theta_r$

Snell's Law:

- $n_1 \sin\theta_1 = n_2 \sin\theta_2$

Mirror Equation:

- $\frac{1}{f} = \frac{1}{u} + \frac{1}{v}$
- Magnification: $m = -\frac{v}{u}$

Lens Equation:

- $\frac{1}{f} = \frac{1}{v} - \frac{1}{u}$
- Lens maker's equation: $\frac{1}{f} = (n-1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$

Power of Lens:

- $P = \frac{1}{f}$ (in meters)

Total Internal Reflection:

- Critical angle: $\sin\theta_c = \frac{n_2}{n_1}$

Prism:

- $\delta = i_1 + i_2 - A$
- Minimum deviation: $\mu = \frac{\sin\frac{A+\delta_m}{2}}{\sin\frac{A}{2}}$

Chapter 10 - Wave Optics

Huygens' Principle:

- Every point on wavefront acts as source of secondary wavelets

Interference:

- Constructive: path difference = $n\lambda$
- Destructive: path difference = $(n + \frac{1}{2})\lambda$

Young's Double Slit:

- Fringe width: $\beta = \frac{\lambda D}{d}$
- $y_n = \frac{n\lambda D}{d}$

Diffraction:

- Single slit: $a \sin\theta = n\lambda$ (minima)

Chapter 11 - Dual Nature of Radiation and Matter

Photoelectric Effect:

- Einstein's equation: $hf = \phi + KE_{\max}$
- $KE_{\max} = eV_0$

de Broglie Wavelength:

- $\lambda = \frac{h}{p} = \frac{h}{mv}$

Photon Energy:

- $E = hf = \frac{hc}{\lambda}$

Chapter 12 - Atoms

Bohr's Model:

- $r_n = \frac{n^2h^2}{4\pi^2mke^2}$
- $E_n = -\frac{13.6}{n^2}$ eV
- $f = \frac{R(n_1^2-n_2^2)}{n_1^2n_2^2}$

Rydberg Constant:

- $R = 1.097 \times 10^7$ m⁻¹

Chapter 13 - Nuclei

Mass-Energy Relation:

- $E = mc^2$

Binding Energy:

- $BE = (\Delta m)c^2$

Radioactive Decay:

- $N = N_0e^{-\lambda t}$
- $T_{1/2} = \frac{0.693}{\lambda}$

Activity:

- $A = \lambda N$

Chapter 14 - Semiconductor Electronics

PN Junction:

- Forward bias: $I = I_0(e^{eV/kT} - 1)$

Rectification:

- Efficiency of half-wave: $\eta = \frac{0.406}{1+r_f/R_L}$
- Efficiency of full-wave: $\eta = \frac{0.812}{1+2r_f/R_L}$

Zener Diode:

- Used as voltage regulator