NCERT CLASS XII PHYSICS – FORMULA SHEET

Chapter 1: Electric Charges and Fields

Coulomb's Law	$F = \frac{1}{4\pi\varepsilon_0}\frac{q_1 q_2}{r^2}$
Electric Field	$\vec{E} = \frac{\vec{F}}{q}$ $E = \frac{1}{4\pi\varepsilon_0}\frac{q}{r^2}$
Electric Field due to Continuous Charge of Line charge:	$E = \frac{\lambda}{2\pi\varepsilon_0 r}$
Electric Field due to Continuous Charge of Infinite plane sheet:	$E = \frac{\sigma}{2\varepsilon_0}$
Gauss's Law	$\oint \vec{E} \cdot d\vec{A} = \frac{Q_{\text{enclosed}}}{\varepsilon_0}$
Electric Dipole	$\vec{p} = q\vec{d}$ $\tau = pE\sin\theta$ $U = -pE\cos\theta$

Chapter 2: Electrostatic Potential and Capacitance

Electric Potential	$V = \frac{W}{q}$ $V = \frac{1}{4\pi\varepsilon_0}\frac{q}{r}$
Relation between E and V	$\vec{E} = -\nabla V$ (Along x-axis: $E = -\frac{dV}{dx}$)
Potential due to Dipole (axial)	$V = \frac{1}{4\pi\varepsilon_0}\frac{p}{r^2}$
Potential Energy	$U = qV$
Capacitance	$C = \frac{Q}{V}$
Capacitors • **Parallel combination:**	$C_{\text{eq}} = C_1 + C_2 + \cdots$
• **Series combination:**	$\frac{1}{C_{\text{eq}}} = \frac{1}{C_1} + \frac{1}{C_2}$

Chapter 3: Current Electricity

Current	$I = \frac{dq}{dt}$
Ohm's Law	$V = IR$
Resistance	$R = \rho \frac{l}{A}$
Resistance Temperature Dependence	$R = R_0(1 + \alpha T)$
Drift Velocity	$v_d = \frac{I}{nqA}$ $v_d = \mu E$
Mobility	$\mu = \frac{q\tau}{m}$
Current Density	$\vec{J} = nq\vec{v}_d$ $\vec{J} = \sigma \vec{E}$
Conductivity	$\sigma = \frac{1}{\rho} = \frac{nq^2\tau}{m}$
Electrical Power	$P = VI = I^2R = \frac{V^2}{R}$

Chapter 4: Moving Charges and Magnetism

Lorentz Force	$\vec{F} = q(\vec{E} + \vec{v} \times \vec{B})$
Force on Current-Carrying Conductor	$F = BIl\sin\theta$
Magnetic Field due to Straight Conductor	$B = \frac{\mu_0 I}{2\pi r}$
Magnetic Field due to Circular Loop (center)	$B = \frac{\mu_0 I}{2R}$ (with N turns: $B = \frac{\mu_0 N I}{2R}$)
Motion of Charged Particle in Magnetic Field	
• **Radius:**	$r = \frac{mv}{qB}$
• **Time period:**	$T = \frac{2\pi m}{qB}$
• **Frequency:**	$f = \frac{qB}{2\pi m}$
Helical Path	$r = \frac{mv\sin\theta}{qB}$ $\text{Pitch} = v\cos\theta \cdot T$
Solenoid	$B = \mu_0 n I$
Magnetic Energy Density	$u = \frac{B^2}{2\mu_0}$

Chapter 5: Magnetism and Matter

Magnetic Dipole Moment	$m = IA$
Torque on Magnetic Dipole	$\tau = mB \sin\theta$
Magnetic Potential Energy	$U = -mB \cos\theta$
Magnetisation	$M = \frac{\text{Magnetic moment}}{\text{Volume}}$
Magnetic Susceptibility	$\chi = \frac{M}{H}$
Relation between B, H, and M	$B = \mu_0(H + M)$
Relative Permeability	$\mu_r = 1 + \chi$
Hall Effect **Hall Voltage**	$V_H = \frac{IB}{nqt}$

Constants Used

$$\varepsilon_0 = 8.85 \times 10^{-12}\ \mathrm{C^2N^{-1}m^{-2}}$$

$$\mu_0 = 4\pi \times 10^{-7}\ \mathrm{T}\backslash\text{cdotpm/A}$$

$$e = 1.6 \times 10^{-19}\ \mathrm{C}$$

Chapter 6: Electromagnetic Induction

Magnetic Flux	$\Phi_B = \vec{B} \cdot \vec{A} = BA\cos\theta$
Faraday's Laws	$\mathcal{E} = -\frac{d\Phi_B}{dt}$ **(Negative sign → Lenz's law)**
Induced EMF (N turns)	$\mathcal{E} = -N\frac{d\Phi}{dt}$
Motional EMF	$\mathcal{E} = Blv$
Induced Current	$I = \frac{\mathcal{E}}{R}$
Self-Inductance	$\mathcal{E} = -L\frac{dI}{dt}$
Self-Inductance of Solenoid	$L = \mu_0\frac{N^2A}{l}$
Mutual Inductance	$\mathcal{E}_2 = -M\frac{dI_1}{dt}$
Energy Stored in Inductor	$U = \frac{1}{2}LI^2$
Energy Density of Magnetic Field	$u = \frac{B^2}{2\mu_0}$

Chapter 7: Alternating Current

AC Voltage / 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:**	$X_L = \omega L$
Reactance • **Capacitive:**	$X_C = \frac{1}{\omega C}$
Impedance (LCR Circuit)	$Z = \sqrt{R^2 + (X_L - X_C)^2}$
Current in AC Circuit	$I_{\text{rms}} = \frac{V_{\text{rms}}}{Z}$
Phase Angle	$\tan \phi = \frac{X_L - X_C}{R}$
Power in AC Circuit	$P = V_{\text{rms}} I_{\text{rms}} \cos \phi$
Power Factor	$\cos \phi = \frac{R}{Z}$
Resonance Condition	$X_L = X_C$ $\omega_0 = \frac{1}{\sqrt{LC}}$
Quality Factor	$Q = \frac{\omega_0 L}{R}$

Chapter 8: Electromagnetic Waves

Speed of EM Wave	$c = \frac{1}{\sqrt{\mu_0 \varepsilon_0}}$
Relation between E and B	$E = cB$
Energy Density	$u = \frac{1}{2}\varepsilon_0 E^2 + \frac{1}{2}\frac{B^2}{\mu_0}$
Intensity of EM Wave	$I = \frac{1}{2} c \varepsilon_0 E_0^2$

EM Spectrum (Order)

Radio → Microwave → Infrared → Visible → UV → X-ray → Gamma

(No numericals beyond these relations in NCERT)

Chapter 9: Ray Optics and Optical Instruments

Mirror Formula	$\frac{1}{f} = \frac{1}{v} + \frac{1}{u}$
Magnification (Mirror)	$m = \frac{h_i}{h_o} = -\frac{v}{u}$
Refraction (Snell's Law)	$n_1 \sin\, i = n_2 \sin\, r$
Refractive Index	$n = \frac{c}{v}$
Apparent Depth	$\text{Apparent depth} = \frac{\text{Real depth}}{n}$
Lens Formula	$\frac{1}{f} = \frac{1}{v} - \frac{1}{u}$
Magnification (Lens)	$m = \frac{v}{u}$
Power of Lens	$P = \frac{1}{f(\text{in m})}$
Combination of Lenses	$P_{\text{eq}} = P_1 + P_2$
Total Internal Reflection	$\sin C = \frac{1}{n}$
Microscope Magnifying Power • **Normal adjustment:**	$M = \frac{D}{f}$
Telescope Magnifying Power	$M = \frac{f_o}{f_e}$

Chapter 10: Wave Optics

Wave Equation	$v = f\lambda$
Superposition Principle	$y = y_1 + y_2$
Young's Double Slit Experiment	**(YDSE)**
• **Path Difference:**	$\Delta x = \frac{xd}{D}$
• **Fringe Width:**	$\beta = \frac{\lambda D}{d}$
• **Maxima Condition:**	$\Delta = n\lambda$
• **Minima Condition:**	$\Delta = (2n+1)\frac{\lambda}{2}$
Intensity Relation	$I = I_1 + I_2 + 2\sqrt{I_1 I_2}\cos\phi$
Diffraction (Single Slit)	$a\sin\theta = n\lambda$
Polarisation *(Malus' Law)*	$I = I_0\cos^2\theta$
Brewster's Law	$\tan i_B = n$

Chapter 11: Dual Nature of Radiation and Matter

Photon Energy	$$E = h\nu = \frac{hc}{\lambda}$$
Photoelectric Equation (Einstein)	$h\nu = \phi + K_{\max}$
Maximum Kinetic Energy	$K_{\max} = h\nu - \phi$
Stopping Potential	$eV_0 = K_{\max}$
Threshold Frequency	$$\nu_0 = \frac{\phi}{h}$$
De Broglie Wavelength	$$\lambda = \frac{h}{p} = \frac{h}{mv}$$
De Broglie Wavelength (Electron accelerated by V)	$$\lambda = \frac{h}{\sqrt{2meV}}$$ **(Relativistic correction, if needed in difficult problems):** $$\lambda = \frac{h}{\sqrt{2meV\left(1 + \frac{eV}{2mc^2}\right)}}$$

Chapter 12: Atoms

Bohr Radius	$r_n = \frac{n^2 h^2 \varepsilon_0}{\pi m e^2}$
Radius of nth Orbit (Hydrogen)	$r_n = n^2 a_0$
Velocity of Electron	$v_n = \frac{e^2}{2\varepsilon_0 h n}$
Total Energy of Electron	$E_n = -\frac{13.6}{n^2}\ \mathrm{eV}$
Energy Difference	$\Delta E = E_{n_2} - E_{n_1}$
Frequency of Emitted Radiation	$h\nu = E_{n_2} - E_{n_1}$
Rydberg Formula	$\frac{1}{\lambda} = R\left(\frac{1}{n_1^2} - \frac{1}{n_2^2}\right)$ **Where:** $R = 1.097 \times 10^7\ \mathrm{m}^{-1}$

Chapter 13: Nuclei

Nuclear Radius	$R = R_0 A^{1/3}$
Mass Defect	$\Delta m = Zm_p + (A - Z)m_n - m_{\text{nucleus}}$
Binding Energy	$BE = \Delta mc^2$
Binding Energy per Nucleon	$\frac{BE}{A}$
Radioactive Decay Law	$N = N_0 e^{-\lambda t}$
Activity	$A = \lambda N$
Half-Life	$T_{1/2} = \frac{\ln 2}{\lambda}$
Mean Life	$\tau = \frac{1}{\lambda}$
Relation	$\tau = \frac{T_{1/2}}{0.693}$
Q-Value of Nuclear Reaction	$Q = (\text{Mass of reactants} - \text{Mass of products})c^2$

Chapter 14: Semiconductor Electronics

Drift Velocity	$v_d = \mu E$
Mobility	$\mu = \frac{e\tau}{m}$
Conductivity	$\sigma = ne\mu$
Resistivity	$\rho = \frac{1}{\sigma}$
Current Density	$J = \sigma E$
Intrinsic Carrier Concentration	$n_e = n_h = n_i$
Relation in Semiconductor	$np = n_i^2$
Diode Equation	$I = I_0 \left(e^{\frac{V}{\eta V_T}} - 1\right)$ **Where:** $V_T = \frac{kT}{e}$
Zener Breakdown Voltage	$V_Z = \text{constant (device property)}$
Rectifier Efficiency	$\eta = \frac{P_{\text{dc}}}{P_{\text{ac}}}$
Ripple Factor	$r = \frac{\text{rms value of ac component}}{\text{dc value}}$
Logic Gates (Basic Relations)	• AND: $Y = A \cdot B$ • OR: $Y = A + B$ • NOT: $Y = \bar{A}$

Important Constants

$$h = 6.63 \times 10^{-34}\ \text{J}\backslash\text{cdotps}$$

$$e = 1.6 \times 10^{-19}\ \text{C}$$

$$m_e = 9.1 \times 10^{-31}\ \text{kg}$$

$$c = 3 \times 10^{8}\ \text{m/s}$$