

CBSE Class XII Physics - Formula Sheet

Session 2026-27 / Handwritten-style revision notes

1. Electric Charges and Fields

Charge and Coulomb's law

Quantisation: $q = ne$

Coulomb force: $F = \frac{1}{4\pi\epsilon_0} \frac{|q_1 q_2|}{r^2} = k \frac{|q_1 q_2|}{r^2}$

In a medium: $F = \frac{1}{4\pi\epsilon} \frac{|q_1 q_2|}{r^2}$, $K = \frac{\epsilon}{\epsilon_0}$

Electric field

$E = \frac{F}{q_0}$; point charge: $E = \frac{1}{4\pi\epsilon_0} \frac{|q|}{r^2}$

Superposition: $\vec{E} = \sum \vec{E}_i$

Continuous: $dq = \lambda dl$, σdA , ρdV

Dipole

Dipole moment: $p = q(2a)$ (from $-q$ to $+q$)

Axial ($r \gg a$): $E = \frac{1}{4\pi\epsilon_0} \frac{2p}{r^3}$

Equatorial ($r \gg a$): $E = \frac{1}{4\pi\epsilon_0} \frac{p}{r^3}$ (opposite to p)

Torque: $\tau = pE \sin \theta$, $\vec{\tau} = \vec{p} \times \vec{E}$

Flux and Gauss's law

Flux: $\Phi_E = EA \cos \theta$

Gauss's law: $\oint \vec{E} \cdot d\vec{A} = \frac{Q_{enc}}{\epsilon_0}$

Infinite line charge: $E = \frac{|\lambda|}{2\pi\epsilon_0 r}$

Infinite plane sheet: $E = \frac{|\sigma|}{2\epsilon_0}$

Conductor surface (just outside): $E = \frac{|\sigma|}{\epsilon_0}$

Spherical shell: outside $E = \frac{kQ}{r^2}$; inside $E = 0$

2. Electrostatic Potential and Capacitance

Potential and potential energy

$V = \frac{W}{q}$; point charge $V = \frac{kq}{r}$

Many charges: $V = \sum \frac{kq_i}{r_i}$

Dipole (far field): $V = \frac{kpc \cos \theta}{r^2}$

Two charges: $U = \frac{kq_1 q_2}{r}$

Dipole: $U = -pE \cos \theta$

$E_x = -\frac{dV}{dx}$

Conductors and capacitance

$$C = \frac{Q}{V}; \quad \text{isolated sphere} \quad C = 4\pi\epsilon_0 R$$

$$\text{Parallel plate: } C = \frac{\epsilon_0 A}{d}; \quad \text{with dielectric} \quad C = \frac{K\epsilon_0 A}{d}$$

$$\text{Series: } \frac{1}{C_{eq}} = \sum \frac{1}{C_i}; \quad \text{two: } C_{eq} = \frac{C_1 C_2}{C_1 + C_2}$$

$$\text{Parallel: } C_{eq} = \sum C_i$$

Energy and combinations

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

$$\text{Energy density: } u = \frac{1}{2} \epsilon_0 E^2$$

Battery connected: V constant; disconnected: Q constant

$$\text{Dielectric inserted: } C' = KC$$

$$\text{fixed } V: Q' = KQ, \quad U' = KU$$

$$\text{fixed } Q: V' = \frac{V}{K}, \quad U' = \frac{U}{K}$$

3. Current Electricity

Current and drift

$$I = \frac{dq}{dt}; \quad \text{steady: } I = \frac{\Delta Q}{\Delta t}$$

$$J = \frac{I}{A}; \quad J = nev_d$$

$$\text{Drift speed: } v_d = \frac{I}{neA}$$

Ohm's law: $V=IR$; $R=\frac{\rho L}{A}$; $\sigma=\frac{1}{\rho}$

$$R=R_0[1+\alpha(T-T_0)]$$

Cells and networks

Discharging: $V=\varepsilon-Ir$; charging: $V=\varepsilon+Ir$

Series cells: $\varepsilon_{eq}=\sum \varepsilon_i$, $r_{eq}=\sum r_i$

n identical in parallel: $\varepsilon_{eq}=\varepsilon$, $r_{eq}=\frac{r}{n}$

Power: $P=VI=I^2R=\frac{V^2}{R}$; $W=Pt$

Series: $R_{eq}=\sum R_i$; parallel: $\frac{1}{R_{eq}}=\sum \frac{1}{R_i}$

Kirchhoff: $\sum I_{in}=\sum I_{out}$; $\sum \Delta V=0$

Wheatstone balance: $\frac{P}{Q}=\frac{R}{S}$

Meter bridge: $\frac{X}{R}=\frac{l}{100-l}$ (check which gap has X)

Potentiometer: $\frac{V_1}{V_2}=\frac{l_1}{l_2}$; $r=R\left(\frac{l_1}{l_2}-1\right)$

4. Moving Charges and Magnetism

Magnetic force and motion

Lorentz force: $\vec{F}=q(\vec{E}+\vec{v}\times\vec{B})$

Magnetic part: $F=|q|vB\sin\theta$

Force on wire: $F=BIL\sin\theta$

$$v \perp B: \quad r = \frac{mv}{|q|B}, \quad \omega = \frac{|q|B}{m}, \quad T = \frac{2\pi m}{|q|B}$$

$$\text{Helical pitch: } \text{pitch} = v_{\parallel} T$$

Magnetic fields

$$\text{Biot-Savart: } dB = \frac{\mu_0}{4\pi} \frac{I dl \sin \theta}{r^2}$$

$$\text{Long straight wire: } B = \frac{\mu_0 I}{2\pi r}$$

$$\text{Centre of } N\text{-turn coil: } B = \frac{\mu_0 NI}{2R}$$

$$\text{On axis of coil: } B = \frac{\mu_0 NI R^2}{2(R^2 + x^2)^{3/2}}$$

$$\text{Ampere's law: } \oint \vec{B} \cdot d\vec{l} = \mu_0 I_{enc}$$

$$\text{Solenoid: } B = \mu_0 n I, \quad n = \frac{N}{L}$$

Torque, dipole and instruments

$$\text{Loop moment: } \mu = NIA$$

$$\tau = \mu B \sin \theta; \quad U = -\mu B \cos \theta$$

$$\text{Parallel wires: } \frac{F}{L} = \frac{\mu_0 I_1 I_2}{2\pi d}$$

$$\text{Galvanometer: } I = \frac{k\theta}{NAB}$$

$$\text{Current sensitivity: } \frac{\theta}{I} = \frac{NAB}{k}; \quad \text{voltage sensitivity: } \frac{\theta}{V} = \frac{NAB}{kG}$$

$$\text{Ammeter shunt: } S = \frac{I_G G}{I - I_G}$$

Voltmeter series resistance: $R = \frac{V}{I_G} - G$

5. Magnetism and Matter

Bar magnet and magnetic materials

Dipole moment $m = \text{pole strength} \times \text{magnetic length}$

Axial: $B = \frac{\mu_0}{4\pi} \frac{2m}{r^3}$

Equatorial: $B = \frac{\mu_0}{4\pi} \frac{m}{r^3}$ (opposite to m)

$\tau = mB \sin \theta$; $U = -mB \cos \theta$

Magnetisation: $M = \frac{m_{\text{net}}}{V}$

$H = \frac{B}{\mu_0} - M$; linear material: $M = \chi_m H$

$\mu_r = 1 + \chi_m$; $B = \mu_0(H + M) = \mu_0 \mu_r H$

Earth: $B_H = B \cos \delta$, $B_V = B \sin \delta$, $\tan \delta = \frac{B_V}{B_H}$

6. Electromagnetic Induction

Flux and Faraday's law

$\Phi_B = BA \cos \theta$

Faraday: $\varepsilon = -N \frac{d\Phi_B}{dt}$; average $|\varepsilon| = N \frac{|\Delta \Phi_B|}{\Delta t}$

Motional emf: $\varepsilon = BLv$

Induced charge: $|q| = \frac{N|\Delta\Phi_B|}{R}$

Inductance

Self: $\varepsilon = -L\frac{dI}{dt}; \quad L = \frac{N\Phi}{I}$

Solenoid: $L = \frac{\mu_0 N^2 A}{l}; \quad \text{with core: } L = \frac{\mu N^2 A}{l}$

Mutual: $\varepsilon_2 = -M\frac{dI_1}{dt}; \quad M = \frac{N_2\Phi_{21}}{I_1}$

Energy: $U = \frac{1}{2}LI^2; \quad \text{density } u = \frac{B^2}{2\mu_0}$

AC generator: $\varepsilon = \varepsilon_0 \sin \omega t, \quad \varepsilon_0 = NBA\omega$

7. Alternating Current

AC basics and circuit values

$i = I_0 \sin \omega t; \quad v = V_0 \sin \omega t; \quad \omega = 2\pi f$

$I_{rms} = \frac{I_0}{\sqrt{2}}; \quad V_{rms} = \frac{V_0}{\sqrt{2}}$

$X_L = \omega L; \quad X_C = \frac{1}{\omega C}$

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

$I_0 = \frac{V_0}{Z}; \quad \tan \phi = \frac{X_L - X_C}{R}$

Power and resonance

$$\cos \phi = \frac{R}{Z}; \quad P = V_{rms} I_{rms} \cos \phi$$

Resistor: in phase. Inductor: i lags v by 90° .

Capacitor: i leads v by 90° .

$$\text{Resonance: } X_L = X_C; \quad \omega_0 = \frac{1}{\sqrt{LC}}; \quad f_0 = \frac{1}{2\pi\sqrt{LC}}; \quad Z = R$$

$$\text{Transformer: } \frac{V_s}{V_p} = \frac{N_s}{N_p} = \frac{I_p}{I_s}$$

$$\text{Efficiency: } \eta = \frac{P_{out}}{P_{in}} \times 100\%; \quad \text{ideal: } V_p I_p = V_s I_s$$

8. Electromagnetic Waves

Wave relations

$$c = \nu \lambda; \quad \text{in vacuum } c = \frac{1}{\sqrt{\mu_0 \epsilon_0}}$$

$$\frac{E_0}{B_0} = c; \quad E \text{ and } B \text{ in phase}$$

$$\text{Intensity: } I = \frac{1}{2} c \epsilon_0 E_0^2 = \frac{c B_0^2}{2 \mu_0}$$

9. Ray Optics and Optical Instruments

Reflection and refraction

$$\text{Mirror: } \frac{1}{f} = \frac{1}{v} + \frac{1}{u}; \quad m = \frac{h_i}{h_o} = -\frac{v}{u}$$

$$n = \frac{c}{v}; \quad \text{Snell: } n_1 \sin i = n_2 \sin r$$

$$\text{Critical angle: } \sin C = \frac{n_2}{n_1}; \quad \text{air: } \sin C = \frac{1}{n}$$

$$\text{Apparent depth} = \frac{\text{real depth}}{n}$$

Surfaces and lenses

$$\text{Spherical surface: } \frac{n_2}{v} - \frac{n_1}{u} = \frac{n_2 - n_1}{R}$$

$$\text{Thin lens: } \frac{1}{f} = \frac{1}{v} - \frac{1}{u}$$

$$\text{Lens maker: } \frac{1}{f} = (n - 1) \left(\frac{1}{R_1} - \frac{1}{R_2} \right)$$

$$m = \frac{h_i}{h_o} = \frac{v}{u}; \quad \text{power } P = \frac{1}{f} \quad (\text{diopetre})$$

$$\text{In contact: } \frac{1}{F} = \sum \frac{1}{f_i}; \quad P = \sum P_i$$

$$\text{Prism: } \delta = i + e - A; \quad n = \frac{\sin \frac{A + \delta_m}{2}}{\sin \frac{A}{2}}$$

Optical instruments

$$\text{Simple microscope: } M = 1 + \frac{D}{f} \quad (\text{near point}); \quad M = \frac{D}{f} \quad (\text{relaxed})$$

$$\text{Telescope (normal adj.): } |M| = \frac{f_o}{f_e}; \quad \text{length} = f_o + f_e$$

$$\text{Compound microscope: } M \approx \frac{L}{f_o} \cdot \frac{D}{f_e}$$

$$D \approx 25 \text{ cm}$$

10. Wave Optics

Interference (YDSE)

Path difference: $\delta = d \sin \theta \approx \frac{dy}{D}$

Constructive: $\delta = n\lambda$; destructive: $\delta = (n + \frac{1}{2})\lambda$

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

Bright: $y_n = n\beta$; dark: $y_n = (n + \frac{1}{2})\beta$

Phase difference: $\phi = \frac{2\pi}{\lambda} \delta$

Diffraction and polarisation

Single-slit minima: $a \sin \theta = n\lambda$, $n = \pm 1, \pm 2, \dots$

Central maximum width $\approx \frac{2\lambda D}{a}$

Malus law (if prescribed): $I = I_0 \cos^2 \theta$

Brewster (if prescribed): $\tan i_B = \frac{n_2}{n_1}$

11. Dual Nature of Radiation and Matter

Photoelectric effect

Photon: $E = h\nu = \frac{hc}{\lambda}$

Einstein: $h\nu = \phi + K_{max} = \phi + \frac{1}{2}mv_{max}^2$

$$K_{max} = eV_s$$

$$\text{Threshold: } \nu_0 = \frac{\phi}{h}; \quad \lambda_0 = \frac{c}{\nu_0} = \frac{hc}{\phi}$$

$$\text{Current} \leftrightarrow \text{intensity}; \quad K_{max} \leftrightarrow \text{frequency}$$

Matter waves

$$\text{de Broglie: } \lambda = \frac{h}{p} = \frac{h}{mv}$$

$$\text{Accelerated through } V: \quad \lambda = \frac{h}{\sqrt{2mqV}}$$

$$\text{Electron: } \lambda (\text{\AA}) \approx \frac{12.27}{\sqrt{V}}$$

12. Atoms

Bohr model and spectra

$$mvr = \frac{nh}{2\pi}$$

$$r_n = \frac{n^2 a_0}{Z}; \quad a_0 \approx 0.529 \text{ \AA}$$

$$E_n = -\frac{13.6 Z^2}{n^2} \text{ eV}$$

$$h\nu = |E_f - E_i|; \quad \lambda = \frac{hc}{|E_f - E_i|}$$

$$\text{Rydberg: } \frac{1}{\lambda} = RZ^2 \left(\frac{1}{n_f^2} - \frac{1}{n_i^2} \right), \quad n_i > n_f$$

$$v_n = 2.18 \times 10^6 \frac{Z}{n} \text{ m s}^{-1}$$

13. Nuclei

Size, mass and energy

$$R = R_0 A^{1/3}, \quad R_0 \approx 1.2 \times 10^{-15} \text{ m}$$

$$\text{Mass defect: } \Delta m = Zm_p + (A - Z)m_n - M$$

$$BE = \Delta m c^2; \quad BE \approx \Delta m(u) \times 931.5 \text{ MeV}$$

$$BE \text{ per nucleon} = \frac{BE}{A}$$

$$Q = (m_{\text{before}} - m_{\text{after}})c^2$$

$$\text{Decay: } N = N_0 e^{-\lambda t} = N_0 \left(\frac{1}{2}\right)^{t/T_{1/2}}$$

$$\text{Activity: } A = \lambda N; \quad T_{1/2} = \frac{\ln 2}{\lambda} \approx \frac{0.693}{\lambda}$$

$$\text{Mean life: } \tau = \frac{1}{\lambda}; \quad \text{after } n \text{ half-lives } N = \frac{N_0}{2^n}$$

$$E = mc^2; \quad 1 \text{ eV} = 1.602 \times 10^{-19} \text{ J}; \quad 1 \text{ uc}^2 \approx 931.5 \text{ MeV}$$

14. Semiconductor Electronics

Diodes and transistors

$$\text{Ohm's law (where applicable): } V = IR$$

Diode is non-linear: use the given I-V graph / data

Ideal diode: forward conducts, reverse blocks

$$\text{Half-wave: } f_{\text{out}} = f_{\text{in}}; \quad \text{full-wave: } f_{\text{out}} = 2f_{\text{in}}$$

$$I_E = I_B + I_C; \quad \alpha = \frac{I_C}{I_E}; \quad \beta = \frac{I_C}{I_B}$$

$$\beta = \frac{\alpha}{1 - \alpha}$$

Useful constants

$$\epsilon_0 = 8.854 \times 10^{-12} \text{ F m}^{-1}; \quad \mu_0 \approx 4\pi \times 10^{-7} \text{ T m A}^{-1}$$

$$k = \frac{1}{4\pi\epsilon_0} \approx 8.99 \times 10^9 \text{ N m}^2 \text{ C}^{-2}$$

$$c = 3.00 \times 10^8 \text{ m s}^{-1}; \quad h = 6.626 \times 10^{-34} \text{ J s}$$

$$e = 1.602 \times 10^{-19} \text{ C}; \quad m_e = 9.11 \times 10^{-31} \text{ kg}$$

$$m_p \approx 1.673 \times 10^{-27} \text{ kg}; \quad m_n \approx 1.675 \times 10^{-27} \text{ kg}$$

$$1 \text{ eV} = 1.602 \times 10^{-19} \text{ J}; \quad 1 \text{ u} c^2 \approx 931.5 \text{ MeV}$$