CLASS 12 PHYSICS — FORMULA SHEET

Chapter 12 : Atoms (NCERT)

12.1 Atomic Models

Model	Key Idea
Thomson's model	Positive charge spread uniformly with electrons embedded (plum pudding)
Rutherford's model	Tiny dense positive nucleus ; electrons orbit around it
Alpha-scattering result	Most pass straight ; few deflected ; very few rebound → nucleus is tiny
Distance of closest approach	$r_0 = (1/4\pi\varepsilon_0)(2Ze^2 \div KE)$
Impact parameter	$b = (Ze^2 \cot(\theta/2)) \div (4\pi\varepsilon_0 \times KE)$
Drawback of Rutherford	Orbiting electron should radiate & spiral in (unstable atom)

12.2 Bohr's Model (Postulates)

Postulate	Statement / Formula
Stable orbits	Electrons revolve in fixed orbits without radiating energy
Quantisation of angular momentum	$mvr = nh \div (2\pi)$; n = 1, 2, 3 …
Energy emission/absorption	$h\nu = E_2 - E_1$ (transition between orbits)
Applies to	Hydrogen and hydrogen-like ions (He^+, Li^{2+})

12.3 Bohr Model — Derived Formulas

Quantity	Formula	Quick Value
Radius of nth orbit	$r_n = (0.529 \times n^2/Z)$ Å	$r_1(H) = 0.529$ Å
Velocity of electron	$v_n = (2.18 \times 10^6 \times Z/n)$ m/s	$v_1(H) \approx c/137$
Energy of nth orbit	$E_n = -13.6 \times Z^2/n^2$ eV	$E_1(H) = -13.6$ eV
Kinetic energy	$KE = +13.6\ Z^2/n^2$ eV $= -E_n$	Positive
Potential energy	$PE = -27.2\ Z^2/n^2$ eV $= 2E_n$	Negative
Total : KE : PE	E : KE : PE = 1 : −1 : 2 (TE = −KE = PE/2)	—
Frequency of revolution	$f = v \div (2\pi r)$	—

12.4 Hydrogen Spectrum

Concept	Formula / Detail
Rydberg formula	$1/\lambda = R\ Z^2\ (1/n_1^2 - 1/n_2^2)$; $R = 1.097 \times 10^7\ m^{-1}$
Lyman series	$n_1 = 1 \rightarrow$ ultraviolet
Balmer series	$n_1 = 2 \rightarrow$ visible
Paschen series	$n_1 = 3 \rightarrow$ infrared
Brackett series	$n_1 = 4 \rightarrow$ infrared

Concept	Formula / Detail
Pfund series	$n_1 = 5 \rightarrow$ infrared
Ionisation energy (H)	13.6 eV (n = 1 to ∞)
Max spectral lines	From level n: n(n−1)/2

12.5 Energy Levels & Transitions

Concept	Detail
Energy of hydrogen levels	n=1: −13.6 ; n=2: −3.4 ; n=3: −1.51 ; n=4: −0.85 eV
Excitation energy	Energy to raise an electron from ground state to higher level
Ionisation energy	Energy to remove electron completely ($n \rightarrow \infty$)
Energy of emitted photon	$\Delta E = 13.6\ Z^2\ (1/n_1^2 - 1/n_2^2)$ eV
Wavelength emitted	$\lambda = hc \div \Delta E = 1240 \div \Delta E(eV)$ nm

★ QUICK MEMORY AIDS & TRICKS

Angular momentum	mvr = nh/2π — the quantisation condition (n = 1, 2, 3...).
Energy levels	$E_n = -13.6\ Z^2/n^2$ eV. n=1 → −13.6, n=2 → −3.4, n=3 → −1.51 eV.
E : KE : PE	Total = −KE = PE/2. Ratio 1 : −1 : 2 (handy check).
Radius & velocity	$r_n \propto n^2/Z$ (grows) ; $v_n \propto Z/n$ (shrinks) with higher n.
Spectrum series	'Lyman UV, Balmer Visible, Paschen+ Infrared.'
Rydberg	$1/\lambda = RZ^2(1/n_1^2 - 1/n_2^2)$. R = 1.097 × 10^7 m^{-1}.
Spectral lines	From level n down to ground: n(n−1)/2 possible lines.
Ionisation energy	Hydrogen ground state needs 13.6 eV to fully ionise.