CHEMWHIZ QUICK REFERENCE

TOPIC 12

Electron Structure & Light

Quantum numbers, orbital filling, electron configurations, and the light/energy relationships.

01 Quantum numbers — CORE RULE

n = 1, 2, 3, … . For each n, ℓ = 0 to n−1. For each ℓ, m_l = −ℓ to +ℓ in integer steps. m_s = +½ or −½.

02 Subshell codes — REFERENCE

ℓ	Letter	Max e⁻
0	s	2
1	p	6
2	d	10
3	f	14

03 Electrons per subshell — CORE RULE

A subshell holds 2(2ℓ+1) electrons: s = 2, p = 6, d = 10, f = 14.

04 Pauli exclusion — CORE RULE

No two electrons in an atom share all four quantum numbers. One orbital (n, ℓ, m_l) holds at most 2 electrons, with opposite spins.

05 Aufbau fill order — CORE RULE

Fill by increasing energy: 1s 2s 2p 3s 3p 4s 3d 4p 5s 4d 5p 6s 4f 5d 6p 7s 5f 6d 7p.

06 Hund's rule — CORE RULE

Within a degenerate subshell, place one electron in each orbital (parallel spins) before pairing. Maximum-multiplicity ground state is most stable.

07 Cr & Cu exceptions — WATCH OUT

Cr = [Ar] $4s^1\ 3d^5$ and Cu = [Ar] $4s^1\ 3d^{10}$ (also Mo, Ag, Au): half-filled d^5 and filled d^{10} stability beats the naive Aufbau prediction.

08 Ion configurations — CORE RULE

Cations lose the highest-n (ns) electrons first, before (n−1)d: Fe [Ar] $4s^2\ 3d^6 \rightarrow Fe^{3+}$ [Ar] $3d^5$.

Anions add electrons in Aufbau order to the next noble gas: O [He] $2s^2\ 2p^4 + 2e^- \rightarrow O^{2-}$ [Ne].

09 Photon energy — CORE RULE

E = hν and c = λν, so E = hc/λ. h = 6.626 × 10^{-34} J·s, c = 2.998 × 10^8 m/s. Higher frequency = shorter wavelength = higher energy.

10 Bohr energies & transitions — CORE RULE

Hydrogen-like orbital energy: $E_n = -2.179 \times 10^{-18}\ J \cdot Z^2 / n^2$ (Z = 1 for H).

Transition: ΔE = E_f − E_i (emit if < 0, absorb if > 0). Photon wavelength λ = hc / |ΔE|.

11 de Broglie wavelength — CORE RULE

λ = h / (m·v) = h/p, for a particle of mass m and velocity v. Use SI units (kg, m/s, J·s); λ comes out in metres. Larger momentum (m·v) gives a shorter wavelength.