

Electron Structure & Light

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

01 Quantum numbers

CORE RULE

$n = 1, 2, 3, \dots$. For each n , $\ell = 0$ to $n-1$. For each ℓ , $m_\ell = -\ell$ to $+\ell$ in integer steps. $m_s = +\frac{1}{2}$ or $-\frac{1}{2}$.

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 $2(2\ell+1)$ 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] 4s¹ 3d⁵ and Cu = [Ar] 4s¹ 3d¹⁰ (also Mo, Ag, Au): half-filled d⁵ and filled d¹⁰ 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] 4s² 3d⁶ → Fe³⁺ [Ar] 3d⁵.

Anions add electrons in Aufbau order to the next noble gas: O [He] 2s² 2p⁴ + 2e⁻ → O²⁻ [Ne].

09 Photon energy

CORE RULE

$E = h\nu$ and $c = \lambda\nu$, so $E = hc/\lambda$. $h = 6.626 \times 10^{-34}$ J·s, $c = 2.998 \times 10^8$ m/s. Higher frequency = shorter wavelength = higher energy.

10 Bohr energies & transitions

CORE RULE

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

Transition: $\Delta E = E_f - E_i$ (emit if < 0 , absorb if > 0). Photon wavelength $\lambda = hc / |\Delta E|$.

11 de Broglie wavelength

CORE RULE

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