

Periodic Properties & Trends

Effective nuclear charge and the radius, ionization energy, electron affinity, electronegativity, and ionic-size trends.

01 Effective nuclear charge

CORE RULE

Z_{eff} = protons minus shielding by core and same-shell electrons (core shields well, same-shell poorly). It rises left-to-right across a period and drives the radius and IE trends.

02 Atomic radius

CORE RULE

Radius increases down a group (higher n shell) and decreases across a period (higher Z_{eff} pulls the same-shell valence electrons in tighter).

03 Ionization energy

CORE RULE

IE_1 rises across a period, falls down a group. Two dips: $\text{Be} \rightarrow \text{B}$ (B loses a higher-energy $2p$) and $\text{N} \rightarrow \text{O}$ (O loses a paired $2p$, restoring half-filled stability).

04 Successive IE jump

CORE RULE

$IE_1 < IE_2 < IE_3 \dots$ always. A sharp jump appears when the next electron removed is a core electron: a jump after IE_n means n valence electrons.

05 Electron affinity

CORE RULE

EA generally becomes more negative across a period. Exceptions: groups 2, 15, 18. Cl has the most negative EA (adding an electron to tiny F is destabilized by repulsion).

06 Electronegativity

CORE RULE

Electronegativity (Pauling) increases up and to the right; F is highest ($\chi = 3.98$). Use it qualitatively, for ranking and comparison.

07 Ionic radius

CORE RULE

A cation is smaller than its atom (fewer electrons, higher Z_{eff} each; main-group cations expose the inner shell).

An anion is larger than its atom (added electrons raise repulsion, lower Z_{eff} each). S: $104 \rightarrow \text{S}^{2-} 170 \text{ pm}$.

08 Isoelectronic series

CORE RULE

Same electron count = isoelectronic. Radius shrinks as Z rises. 10-e^- set: $\text{N}^{3-} > \text{O}^{2-} > \text{F}^- > \text{Ne} > \text{Na}^+ > \text{Mg}^{2+} > \text{Al}^{3+}$.

09 Bond character from ΔEN

REFERENCE

ΔEN	Bond type
$< \sim 0.4$	nonpolar covalent
~ 0.4 to $< \sim 1.7$	polar covalent
$\geq \sim 1.7$	ionic

Rough guide only: the thresholds are heuristic, and some borderline cases go by chemistry (e.g. NaH , $\Delta EN \approx 1.2$, is treated as ionic).

10 Group similarity

CORE RULE

Same-group elements share a valence configuration (Ca, Sr, Ba are ns^2) so they share reactivity, oxidation states, and bonding. Diagonal likenesses ($\text{Be} \leftrightarrow \text{Al}$, $\text{Li} \leftrightarrow \text{Mg}$) are secondary.