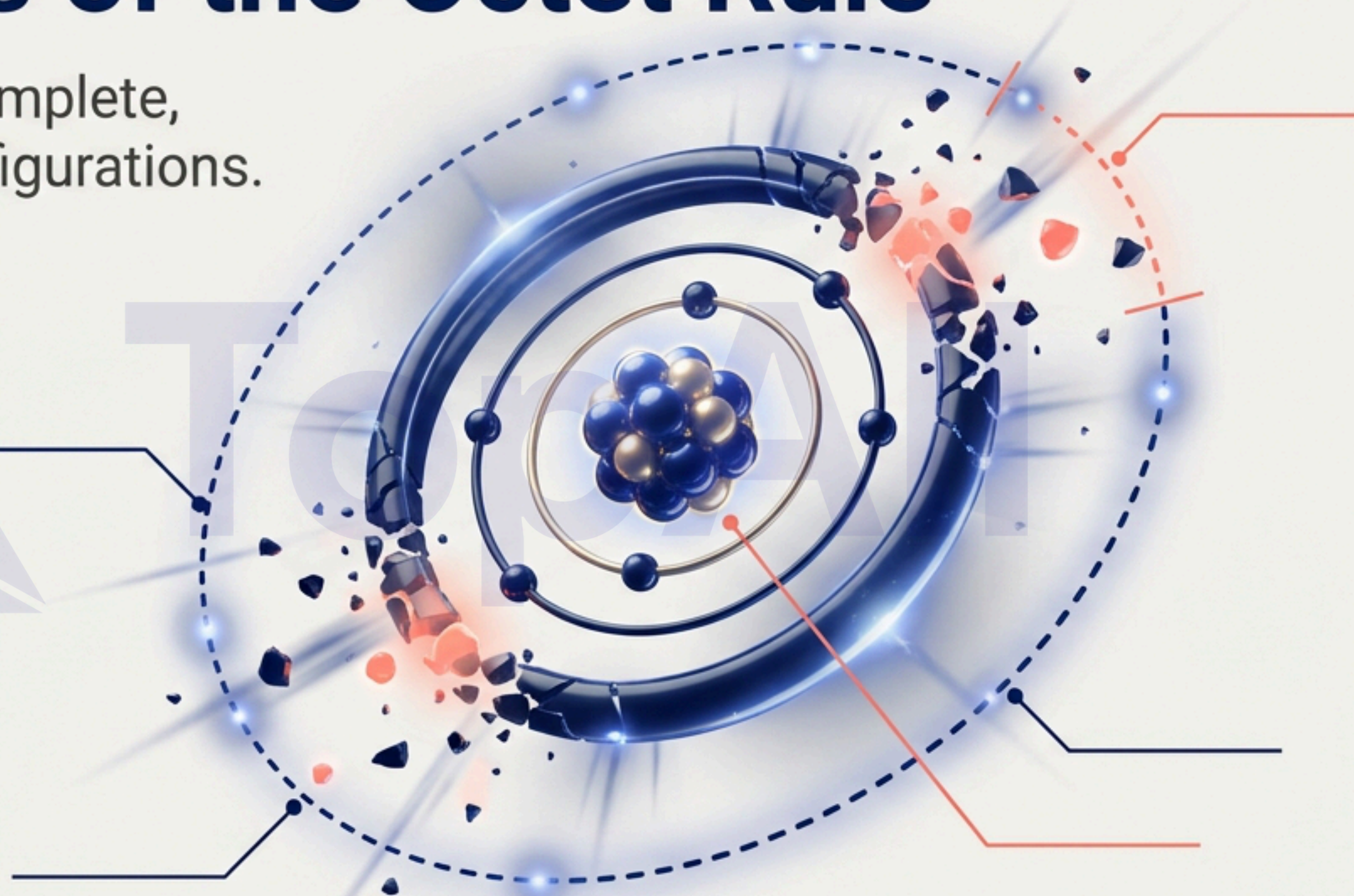
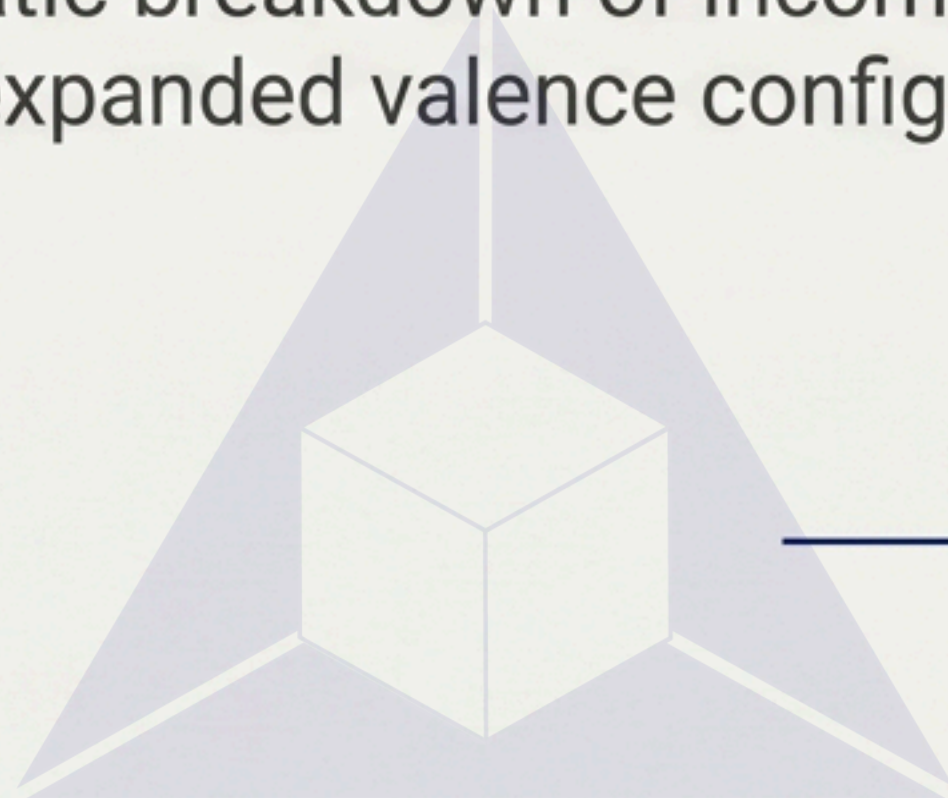


4.1.5 Limitations of the Octet Rule

A systematic breakdown of incomplete, odd, and expanded valence configurations.

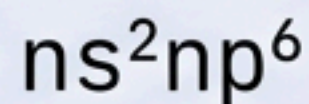


CONTEXT & BOUNDARIES

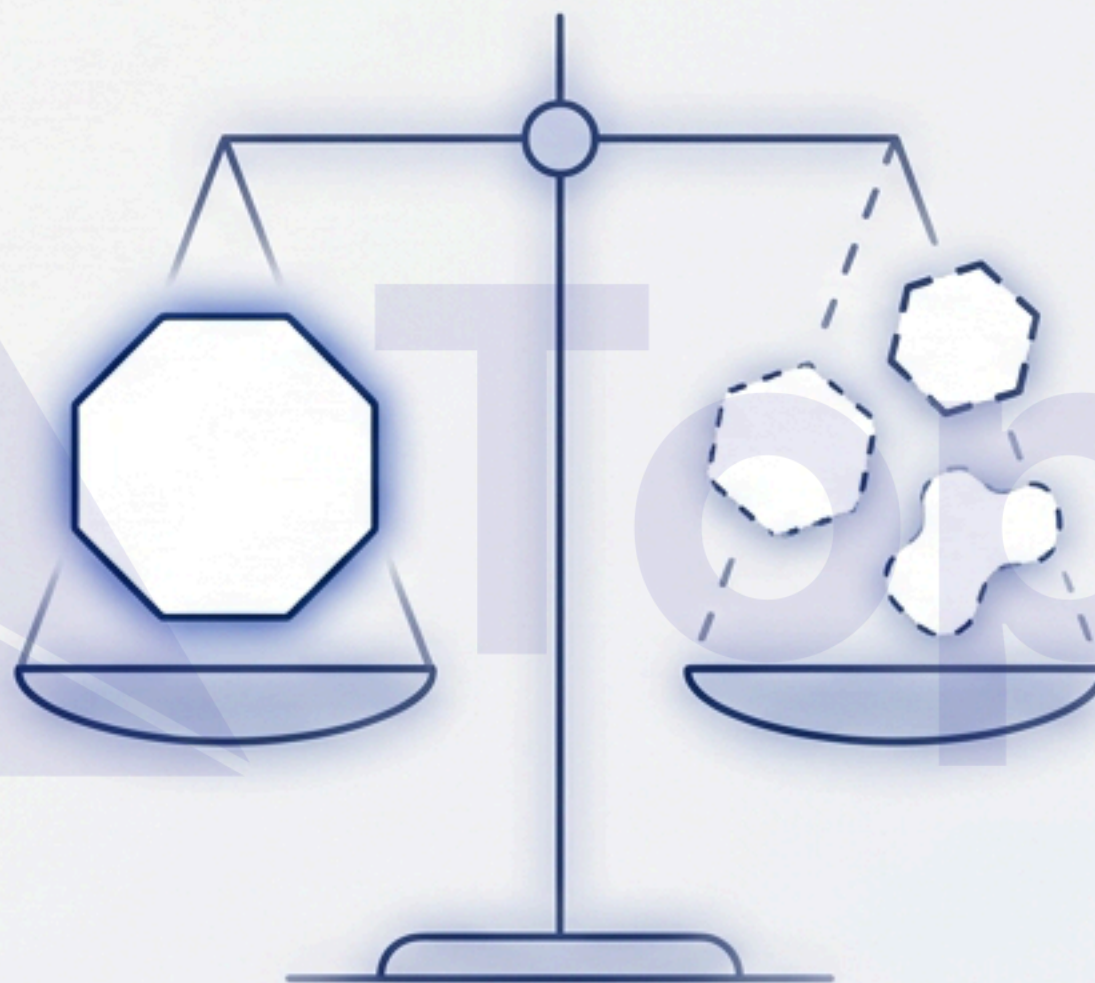
Why the Octet Rule Is Useful but Not Universal

Where it Works

- Highly reliable for organic compounds.
- Applies almost universally to second-period elements (C, N, O, F).



stable noble gas configuration



Where it Breaks

- Fails when accounting for elements with < 4 valence electrons.
- Fails for elements in the 3rd period and beyond (access to d-orbitals).
- Fails for molecules with odd electron counts.

The octet rule is a structural heuristic, not an absolute law of quantum mechanics.

The Incomplete Octet

Occurs when the central atom is surrounded by fewer than eight electrons. Typical for elements with less than four valence electrons (Li, Be, B).

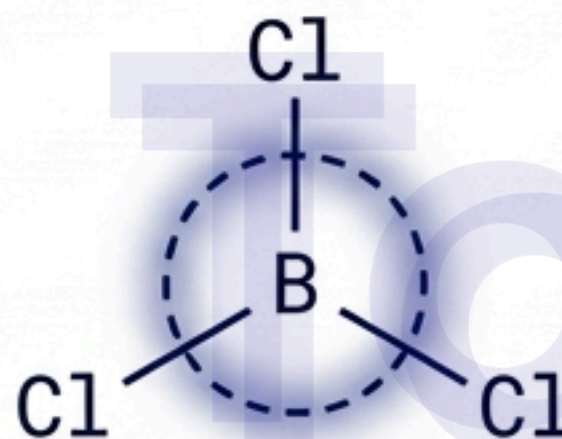
Molecule Profile



Be: 4e⁻

BeH₂

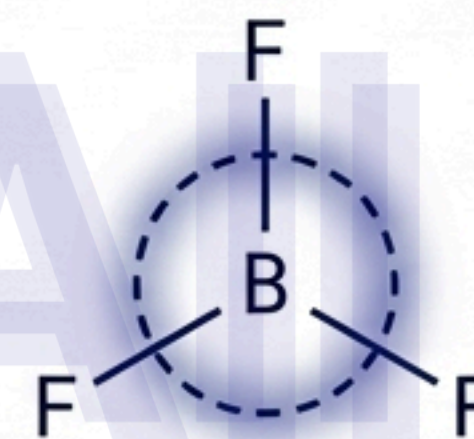
Molecule Profile



B: 6e⁻

BCl₃

Molecule Profile



B: 6e⁻

BF₃

Elements like Beryllium and Boron form stable molecules despite severe electron deficiency.



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LIMITATION 02

Odd-Electron Molecules

In molecules with an odd total number of electrons, the octet rule cannot be satisfied for all atoms simultaneously.

Molecule Profile



Total: 11e⁻

Molecule Profile



Total: 17e⁻

The presence of a single, unpaired radical electron mathematically guarantees that at least one atom will not achieve a full octet of 8.

The Expanded Octet

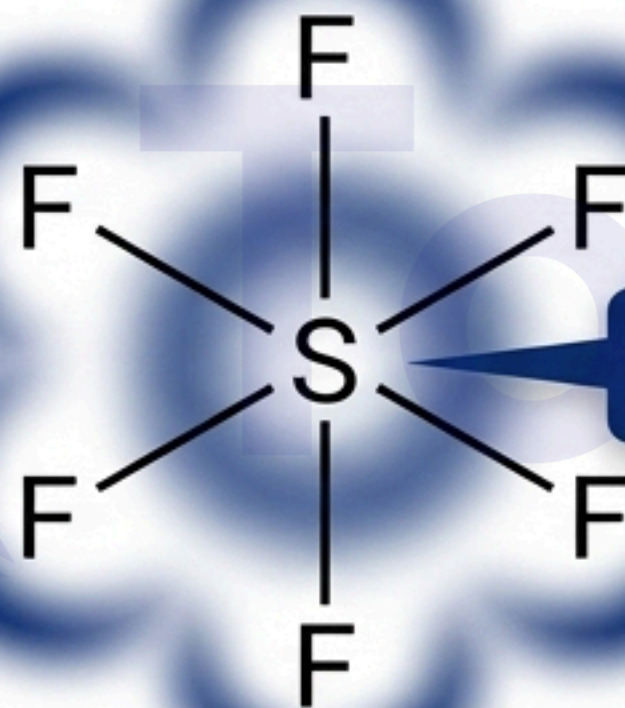
Elements in and beyond the 3rd period can utilize vacant 3d orbitals for bonding, allowing more than eight valence electrons around the central atom.

Molecule Profile

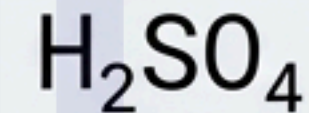


(Phosphorus pentafluoride)

P: 10e⁻



Molecule Profile



(Sulfuric acid)

S: 12e⁻

Note: Sulfur can also form standard octets (e.g., SCl_2), making expansion an available option, not a requirement.

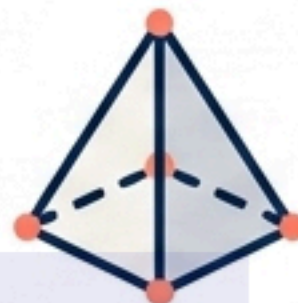
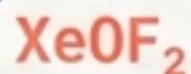
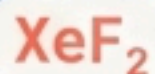
Other Drawbacks of the Octet Theory



Noble Gas Reactivity

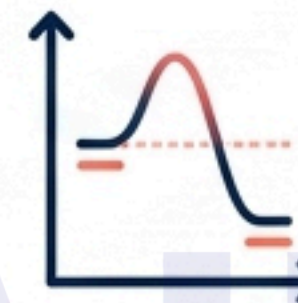
The rule assumes noble gases are perfectly inert.

Reality: Kr and Xe react with F and O.



Molecular Shape

The theory is completely silent on the 3D geometry of molecules (requiring VSEPR theory to fill the gap).

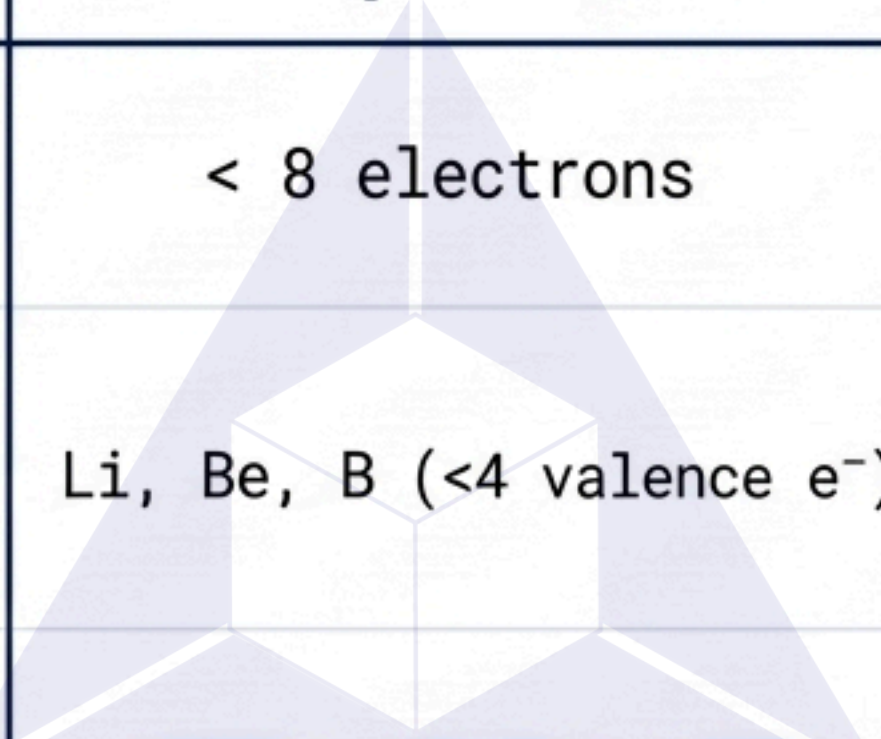


Relative Stability

The rule does not account for the energy of a molecule or explain why one octet-compliant molecule is more stable than another.

The octet rule describes a state of bonding, but not the complete physical reality of the molecule.

The Octet Exception Rulebook

	Incomplete Octet	Odd-Electron	Expanded Octet
Defining Trait:	< 8 electrons	Unpaired single e^-	> 8 electrons
Typical Elements:	Li, Be, B (<4 valence e^-)	Nitrogen oxides	3rd Period & beyond (utilizing 3d orbitals)
Examples:	 BeH ₂ BCl ₃ BF ₃	NO NO ₂	PF ₅ SF ₆ H ₂ SO ₄

Key Takeaway: The Octet Rule is a highly helpful structural guide for 2nd-period elements, but it is not a universal law of chemical bonding.



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