

Chapter 3 Synthesis

Valence: The Combining Power of Elements

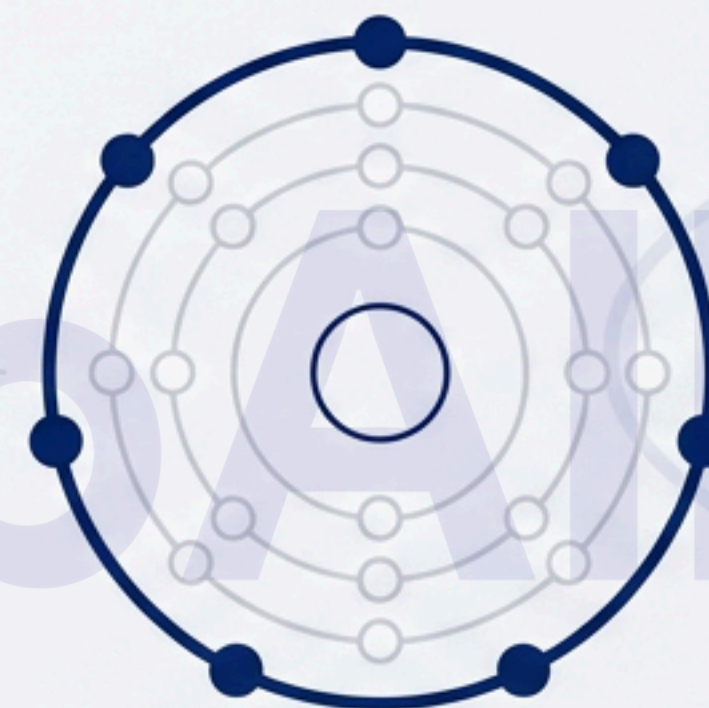
Understanding the relationship between outermost electrons, electronegativity, and oxidation states.

Valence: The Structural Foundation

The valence of an element is its inherent combining power, dictated entirely by the electrons in its outermost shell.

DEFINITION

Valence is usually equal to the number of outermost (valence) electrons, OR equal to eight minus the number of outermost electrons.



[Ne] 3s² 3p⁵

7 valence
electrons



-> Needs 1 to
complete the octet

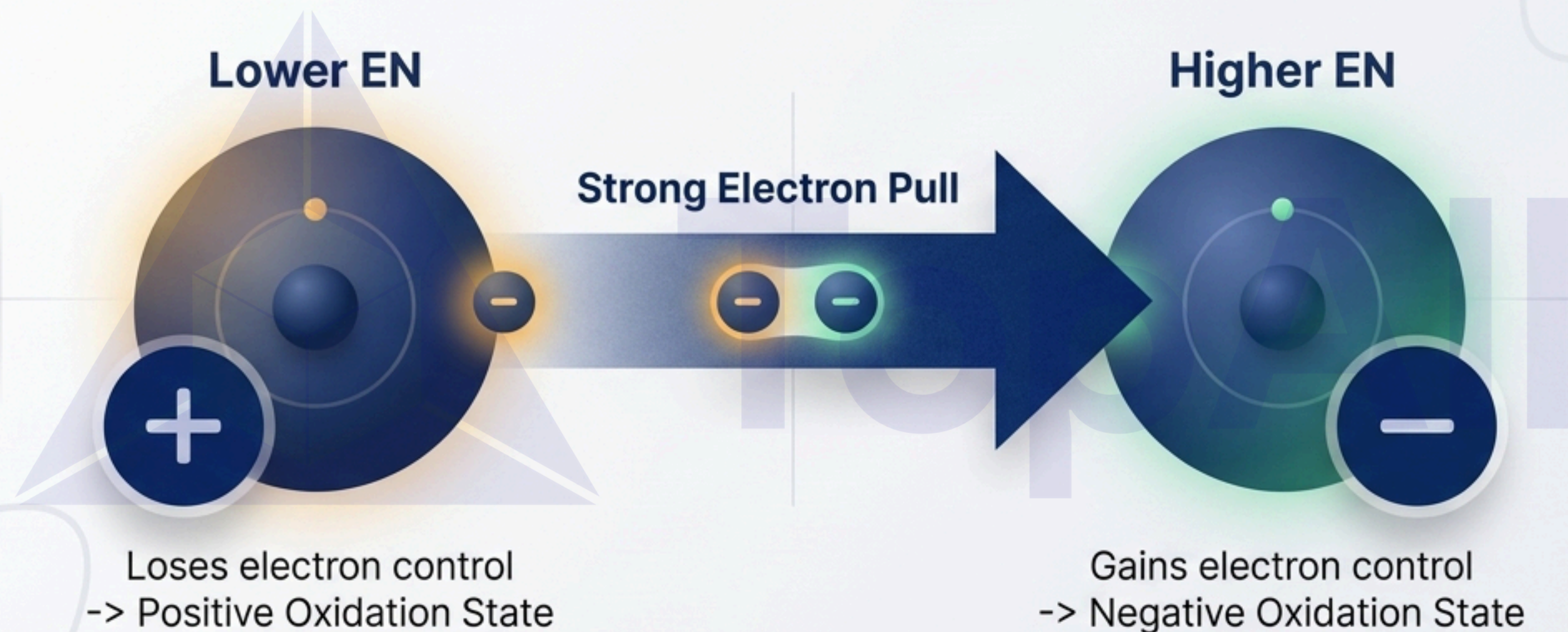


Valence = 1

The Tug-of-War: Oxidation State



While valence tells us how many bonds can form, **Oxidation State** tells us where the electrons actually go.



Oxidation state is the charge an atom acquires based on electronegativity considerations from other atoms in the molecule.



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$$E=mc^2$$



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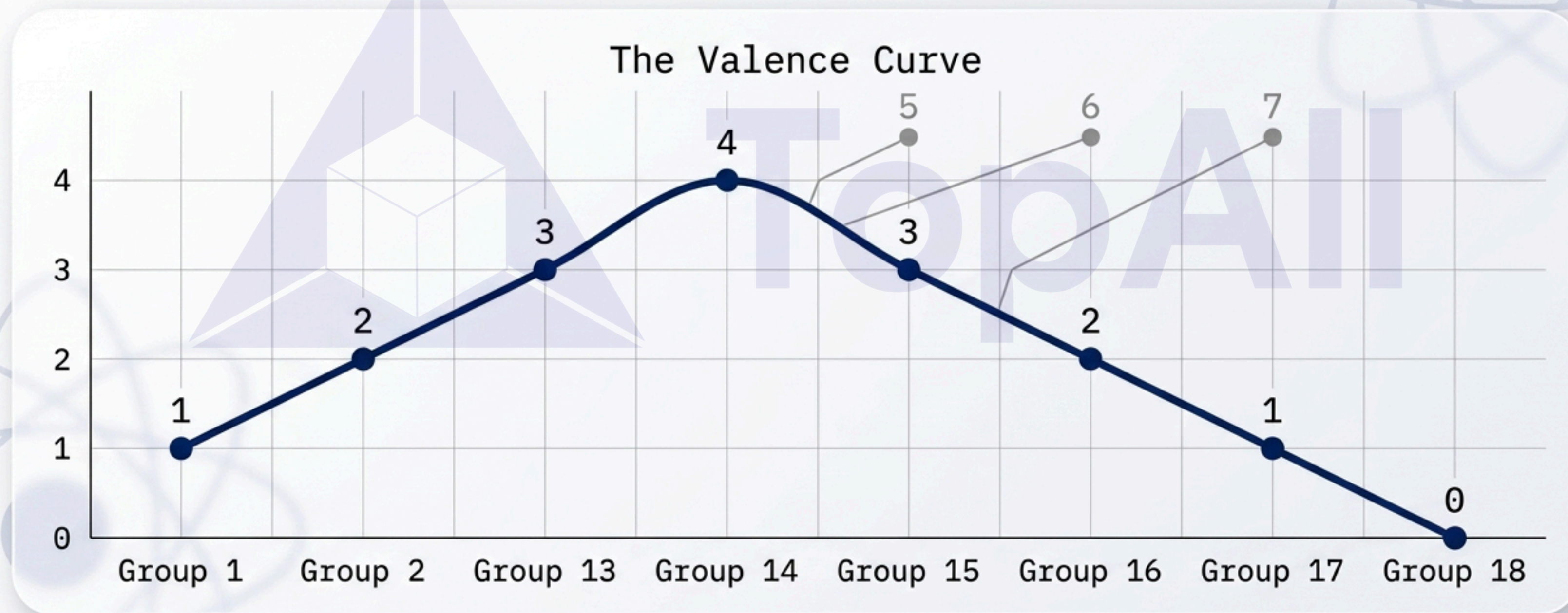
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The Periodic Mountain: Valence Trends

For representative elements (s and p blocks), valence follows a strict, predictable geometric pattern across periods.



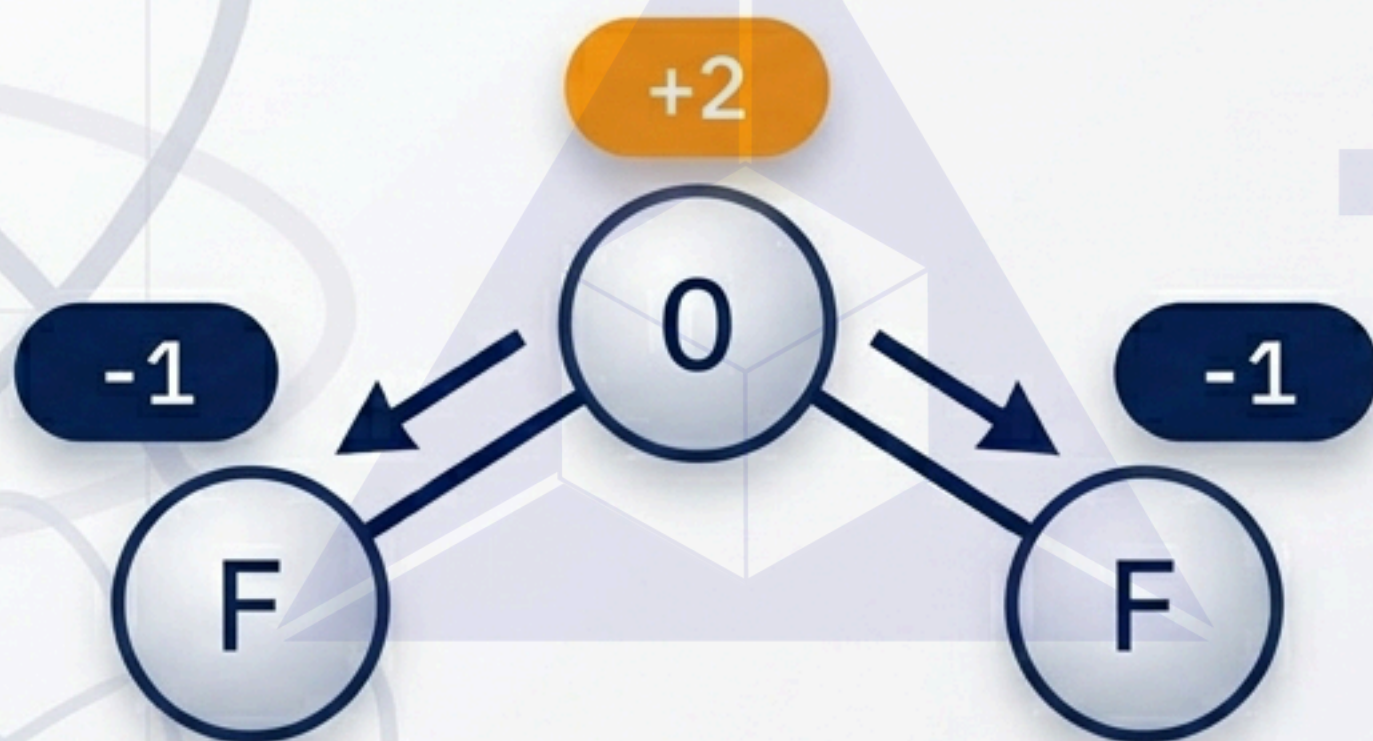
Periodic Trends in Action

Observe how the valence pattern dictates the exact empirical formulas of hydrides and oxides across the periodic table.

	Gr 1	Gr 2	Gr 13	Gr 14	Gr 15	Gr 16	Gr 17
Hydrides	LiH	CaH ₂	B ₂ H ₆	CH ₄	NH ₃	H ₂ O	HF
Oxides	Li ₂ O	MgO	Al ₂ O ₃	CO ₂	N ₂ O ₃ , N ₂ O ₅	SO ₃	Cl ₂ O ₇

The Anomaly: Oxygen in OF_2

Oxygen typically takes electrons, but Fluorine is the ultimate exception. Fluorine's electronegativity forces Oxygen into a rare positive state.



Electronegativity Order: $\text{F} > \text{O}$

Fluorine (F): Takes 1 electron
→ Oxidation State: -1

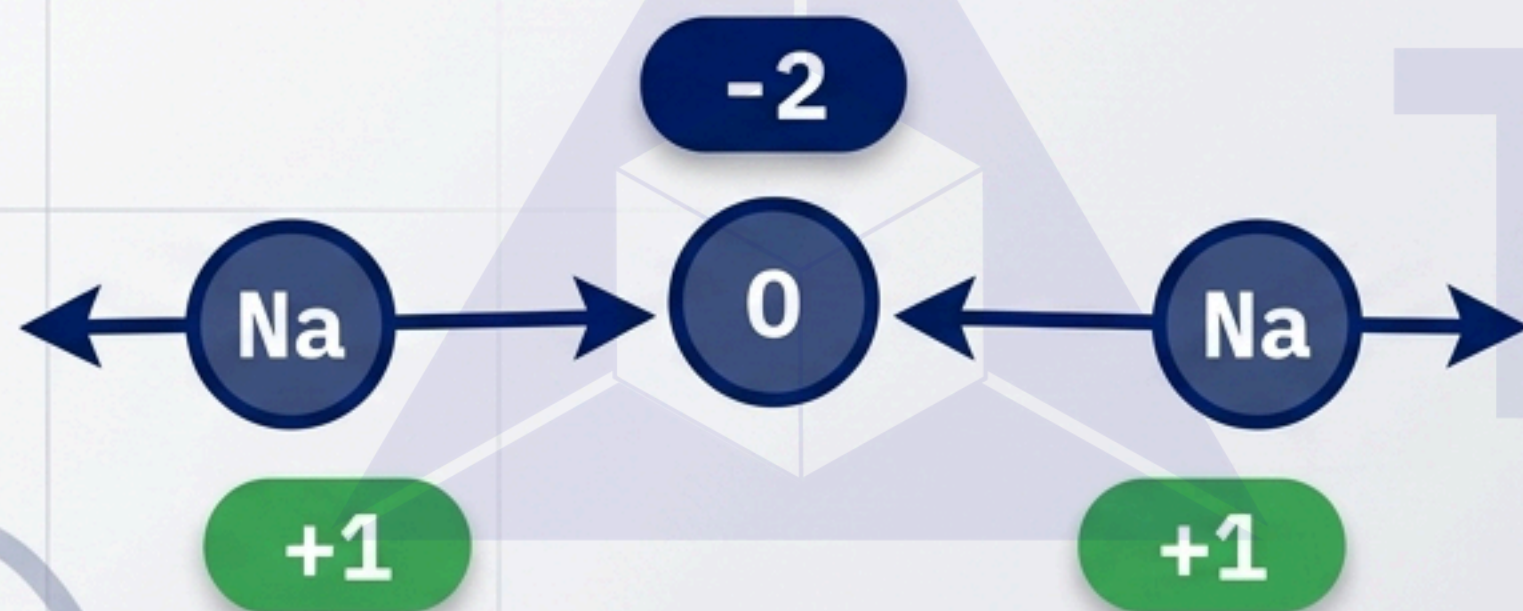
Oxygen (O): Loses 2 electrons (one to each F)
→ Oxidation State: +2



Rare State Detected. Fluorine is the only element electronegative enough to force Oxygen into a positive oxidation state.

The Standard: Oxygen in Na_2O

When bonded to a less electronegative element like Sodium, Oxygen behaves according to its standard operational state, claiming the electrons.



Electronegativity Order: $\text{O} > \text{Na}$

Sodium (Na): Loses 1 electron
→ Oxidation State: $+1$

Oxygen (O): Takes 2 electrons
(one from each Na)
→ Oxidation State: -2



Standard State. Oxygen almost always has an oxidation state of -2 in its compounds.

Synthesis & Exam Takeaways



Master these three core principles to decode chemical formulas and predict elemental behavior.

1

The Valence Rule

Valence relies strictly on outer electrons.

Groups 1-14 rise from 1 to 4.

Groups 15-18 drop from 3 to 0 (via the 8 - e^- rule).

2

The Oxidation Rule

Oxidation state is relative. The more electronegative atom in a bond always takes the negative oxidation state.

3

The Oxygen Paradox

Oxygen is almost universally -2 (e.g., Na_2O , MgO , CO_2).

The critical exam exception is OF_2 , where Oxygen becomes +2 because Fluorine is more electronegative.



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