

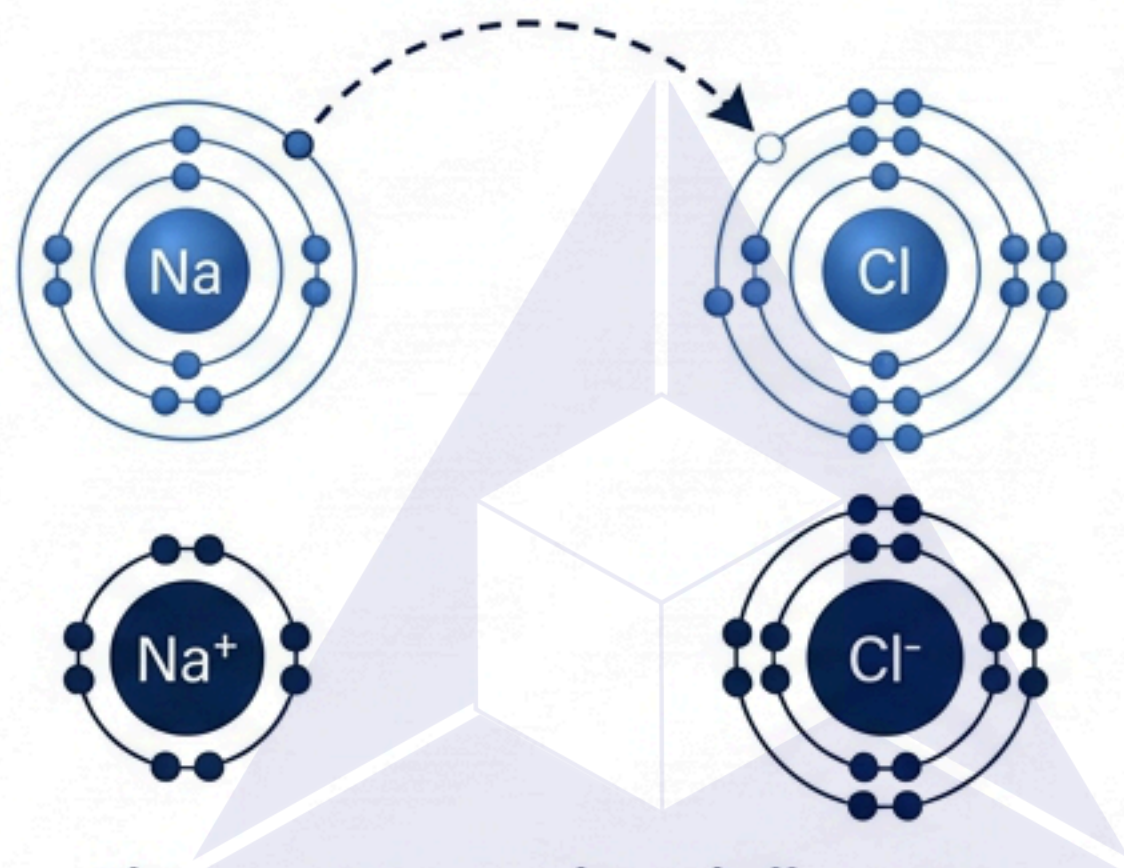
UNIT 7 | REDOX REACTIONS

Oxidation Number

Chemistry's Accounting System
for Electron Shifts

'The Chemist's Ledger: Electron Bookkeeping in Bonding

Absolute Transfer



Charges are real and discrete.
Bookkeeping is obvious.

The Covalent Dilemma

Tug-of-War



Electrons are shared, but not equally.
Charge transfer is only partial—an electron shift
rather than a complete loss or gain.

To keep track of electron shifts, chemists developed a practical method: Oxidation Numbers.
We assume a complete transfer of electrons to the more electronegative atom for the sake of bookkeeping.

'The Chemist's Ledger: Electron Joint Strip



Reactants



Neutral state (zero).
Electrons shared equally.

Products



Hydrogen shifts to a positive state.
Oxygen shifts to a dinegative state.

It is not always possible to intuitively remember which element is more electronegative.
We need a strict set of accounting rules.

'The Chemist's Ledger: Electron Bookkeeping in Bonding'



Oxygen: 0 to -2.
(Assumed electron gain = Reduction).

Hydrogen: 0 to +1.
(Assumed electron loss = Oxidation).

It is not always possible to intuitively remember which element is more electronegative. We need a strict set of accounting rules.



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$$E=mc^2$$



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"The Chemist's Ledger: Electron Accounting Rules"

Free Elements

Oxidation number is strictly zero. (e.g., H_2 , O_2 , P_4 , S_8 , Na).

Monatomic Ions

Equals the charge on the ion. (e.g., $\text{Na}^+ = +1$, $\text{Cl}^- = -1$).

Halogens

Fluorine is always -1.
 Cl , Br , I are -1 as halides, but can be positive when combined with Oxygen.

Group 1 & 2 Metals

Alkali metals are always +1.
Alkaline earth metals are always +2.

Neutral Molecules

The algebraic sum of all oxidation numbers must equal zero.

Polyatomic Ions

The algebraic sum of all oxidation numbers must equal the net charge of the ion (e.g., CO_3^{2-} sum equals -2).

“The Chemist’s Ledger: Warning Profiles & Exceptions”

The Oxygen Exceptions



Standard Rule: Usually -2.

⚠ Warning 1: Peroxides

In H_2O_2 , Na_2O_2 , Oxygen is -1. $\text{O}-\text{O}$

⚠ Warning 2: Superoxides

In KO_2 , RbO_2 , Oxygen is -1/2.

⚠ Warning 3: With Fluorine

In OF_2 it is +2, and in O_2F_2 it is +1.
(Because F is more electronegative).

The Hydrogen Exception



Standard Rule: Usually +1.

⚠ Warning: Metal Hydrides

When bonded to metals in binary compounds (e.g., LiH , NaH , CaH_2), Hydrogen is more electronegative than the metal, so its oxidation number is -1.

Stock Notation: Naming Transition Metals

Transition elements often display variable positive oxidation states. German chemist Alfred Stock designed a notation system placing the oxidation state as a Roman numeral in parentheses.

Gold (Au)

Formula: AuCl



Name: Gold(I) chloride



Au(I)

Formula: AuCl_3



Name: Gold(III) chloride



Au(III)

Tin (Sn)

Formula: SnCl_2



Name: Tin(II) chloride



Sn(II)

Formula: SnCl_4

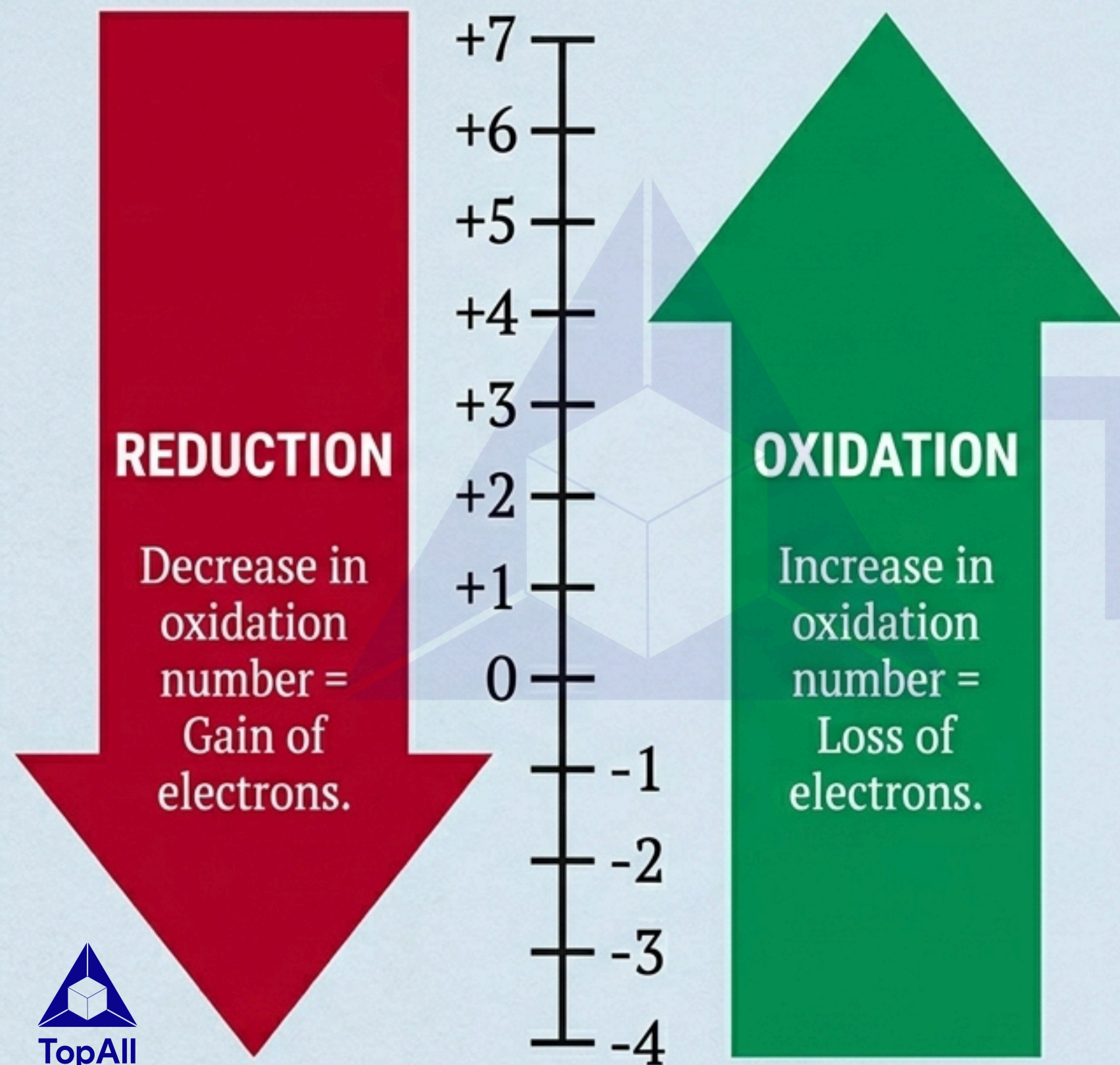


Name: Tin(IV) chloride

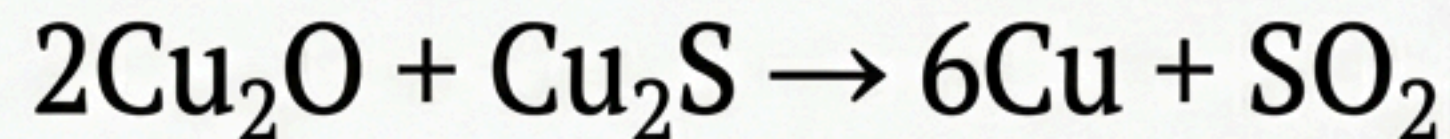


Sn(IV)

"The Chemist's Ledger: Oxidation and Reduction on the Elevator Number Line"



Equation Strip



Sulphur goes from -2 to +4
(Up the line -> Oxidation).



Copper goes from +1 to 0
(Down the line -> Reduction).

Quick Exam Checklist



Maximum Oxidation States

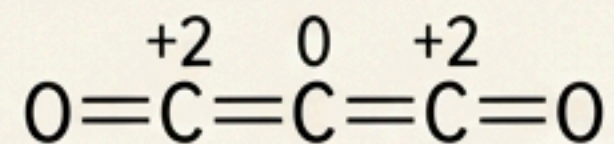
The highest oxidation number of an element generally equals its Group Number (or Group No. minus minus 10 for groups 13-17).

3rd period max ranges from +1 (NaCl) up to +7 (HClO₄).



The Fractional Paradox

Electrons cannot be shared in fractions. A fractional state (e.g., +8/3 in Fe₃O₄) is just an average of different atoms of the same element in different oxidation states within the structure.

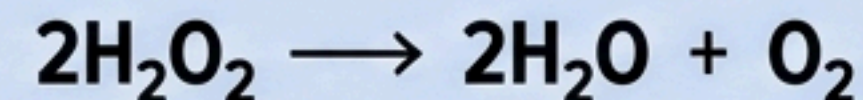


Average = 4/3



Disproportionation Reactions

A special redox reaction where the same element in one oxidation state is simultaneously oxidized (number goes up) AND reduced (number goes down).



(Oxygen goes from -1 down to -2, and up to 0).



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