

Limitations of Oxidation Number

Moving from mathematical book-keeping to the **reality** of electron density.

THE BOOK-KEEPING CONCEPT

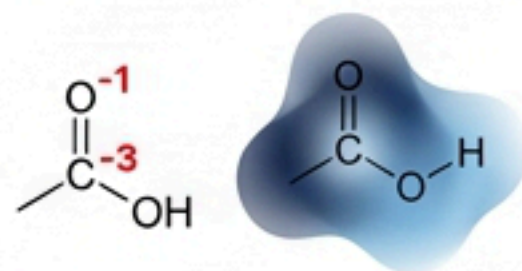
Oxidation numbers are a useful, albeit artificial, mathematical construct to track electron transfer in redox reactions. They treat all bonds as ionic, assigning bonding electrons to the more electronegative atom.

LIMITATION: IONIC PARADOX

They often fail to represent actual charge distribution in covalent and polar covalent bonds, leading to misleading "charges".

CH₃COOH (Acetic Acid)

The central carbon atoms are assigned oxidation numbers of -3 and +3, implying significant charge difference, which does not exist. The reality is a more subtle shift in electron density.



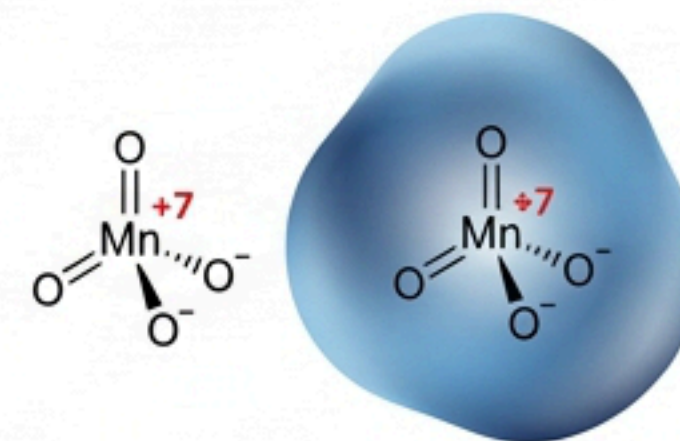
THE ELECTRON DENSITY REALITY

MODERN MODEL: QUANTUM MECHANICS

Electron density is a probability distribution, not fixed points. Electrons are delocalized and shared in varying degrees across molecules, especially in resonance structures and transition metal complexes.

MnO₄⁻ (Permanganate)

Manganese is assigned a formal oxidation state of +7. The reality is extensive delocalization of the charge and electron density over the entire polyatomic ion, not a discrete +7 charge on the Mn atom.



The Evolution of Redox Chemistry

Classical Idea

Addition of Oxygen
or Removal of
Hydrogen.

Electronic Idea

Complete loss or
gain of discrete
electrons (e^-).

Oxidation Number

Assumes complete
electron transfer for
simple book-
keeping.

LIMITATION: Leads to the Fractional Paradox (e.g., C_3O_2 mathematically averages to a $+4/3$ oxidation state, which is physically impossible).

CURRENT MODEL

Modern Concept

Continuous shifts
in fluid electron
density clouds.



You've Learned the Theory. Let's Test Them Now.

$$E=mc^2$$



Turn theory into marks with **unlimited MCQs, smart analysis, and focused revision.**

Practice Now



At prep.topall.app

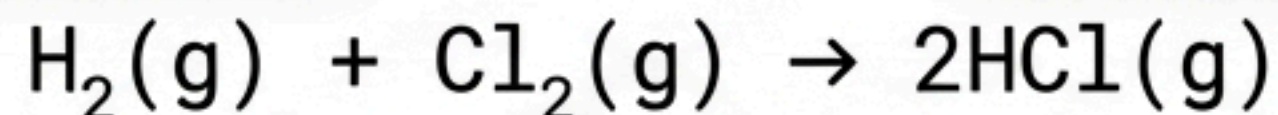
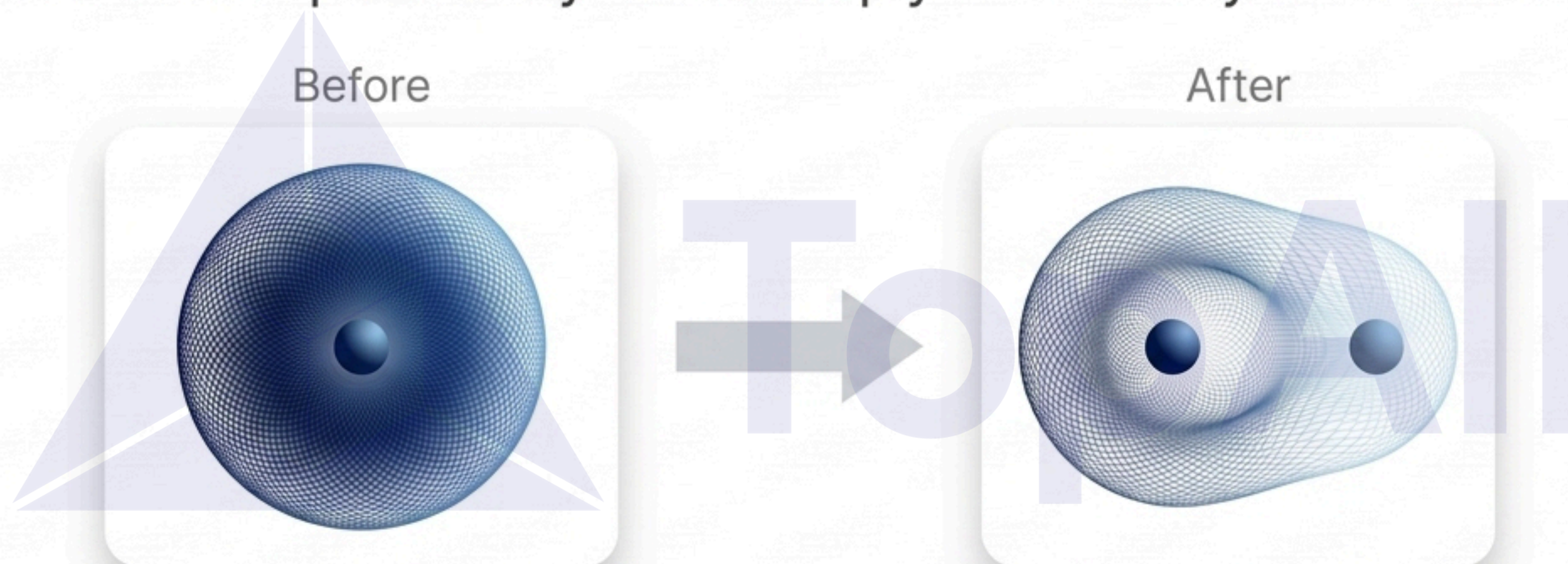
Key Highlights

- » Free Study Material, Videos & Infographics
- » Push Your Limits with Level-Based Challenges
- » Climb the Leaderboard Among Fellow Aspirants
- » Practice Unlimited MCQs for NEET & JEE
- » Get Clear Explanations, Not Just Marks
- » Track Your Performance Smarter



Oxidation = Decrease in Electron Density

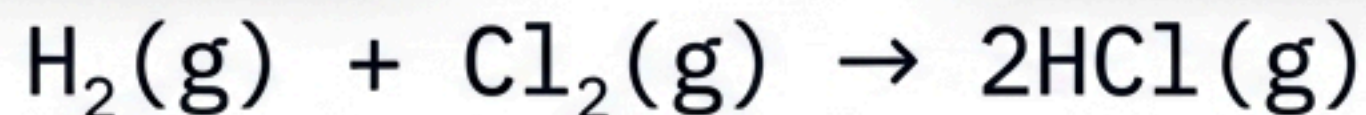
In covalent bonds, charge transfer is rarely a 100% complete loss of electrons. Instead, the electron probability cloud simply shifts away from the atom.



Hydrogen doesn't "lose" a full electron. Its electron density is simply pulled toward the more electronegative Chlorine.

Reduction = Increase in Electron Density

Reduction is visualized not as catching a discrete particle, but as the accumulation and thickening of electron density around an atom involved in the reaction.



Chlorine in HCl doesn't 'gain' a completely free electron. The shared electron cloud simply becomes denser around the chlorine nucleus.

The Final Takeaway

Oxidation Number Model

- A simplified book-keeping tool.
- Highly effective for balancing complex redox equations.
- Assumes 100% complete electron transfer.
- Can lead to artificial fractional oxidation states.

Electron Density Model

- Reflects physical quantum reality.
- Gives deeper physical meaning to redox reactions.
- Accounts for partial electron shifts in polar covalent bonds.
- Explains the true structure and bonding of molecules.

Oxidation numbers are highly useful for mathematical calculations, but electron density provides the true physical meaning of chemical reactions.



You've Learned the Theory.

Now Let's Test It.

Reading notes gets you knowledge.

Practicing MCQs gets you marks.

That's exactly what TopAll Pro is built for.

Try TopAll Pro Now

What TopAll Pro Does Differently

-  **Stuck? Snap it. Solve it. — Doubts AI**
Photo → step-by-step solution in seconds, 24/7
-  **Your AI Coach finds your blind spots**
Concept-level weakness detection — not just chapter-level
-  **4.5 Lakh+ questions. Never run out.**
13× more content than any other prep app in India
-  **Build your own test in 60 seconds**
Pick a chapter, set difficulty — AI does the rest instantly.
-  **AI Recommendation that helps you improve**
AI Recommendation Analysis your Tests and tell you where you need to improve.



Practice the moment you finish studying
Jump in while the concept is still fresh in your head

4.5L+
MCQs

1.5L+
Students

AI Powered
In-Depth Analysis