

Redox Reactions & Balancing

Oxidation numbers, identifying redox and agents, disproportionation, and the half-reaction and oxidation-number methods.

01 Assigning oxidation numbers

CORE RULE

Free element = 0. Monatomic ion = its charge. F = -1. H = +1 (but -1 in metal hydrides). O = -2 (-1 in peroxides, +2 in OF₂). Fixed-charge metals: Group 1 = +1, Group 2 = +2, Al = +3. Variable-charge metals (Sn, Pb, Tl, transition metals): use the Roman numeral or solve with the sum rule.

02 Sum rule (solve for an unknown)

CORE RULE

Oxidation numbers sum to 0 (neutral compound) or to the charge (polyatomic ion). Solve algebraically: H₂SO₄ → S = +6; MnO₄⁻ → Mn = +7.

03 Average oxidation numbers

CORE RULE

A formula-unit average can be fractional and is bookkeeping, not a per-atom state: Fe₃O₄ → Fe = +8/3; S₂O₃²⁻ → S = +2 (avg); S₄O₆²⁻ → S = +2.5 (avg).

04 Redox or not?

CORE RULE

Assign oxidation numbers on both sides. If any element's number changes → redox (name it). If none change → not redox (neutralization, metathesis, hydrolysis).

05 Oxidized / reduced / agents

CORE RULE

Oxidized = number increases (loses e⁻). Reduced = number decreases (gains e⁻). Oxidizing agent = the whole species reduced; reducing agent = the whole species oxidized. Name the full formula (HNO₃, not N).

06 Disproportionation & comproportionation

CORE RULE

Disproportionation: one element is both oxidized and reduced (2H₂O₂ → 2H₂O + O₂). Comproportionation: two states of one element converge to one (NH₄NO₃ → N₂O + 2H₂O).

07 Non-redox traps

WATCH OUT

Looks like redox but isn't (no ox-number change): halide/phosphide hydrolysis (PCl₃ + 4H₂O → H₃PO₄ + 5HCl), peroxide preservation, and acid-base neutralization. Check every element first.

08 Half-reaction method (acidic)

METHOD

Split into two half-reactions; balance non-H/O atoms; balance O with H₂O; balance H with H⁺; balance charge with e⁻ (e⁻ on right = oxidation, on left = reduction); scale to equal e⁻; add and cancel.

09 Half-reaction method (basic)

METHOD

Balance as if acidic, then add one OH⁻ to both sides for each H⁺; combine H⁺ + OH⁻ → H₂O; cancel duplicate H₂O. The final answer has OH⁻ and H₂O but no H⁺.

10 Match the electrons

CORE RULE

Electrons transferred must be equal in both halves: scale each to the LCM of the two counts (2 & 3 → 6). After summing, electrons must cancel completely; leftover e⁻ means the multipliers are wrong.

11 Oxidation-number method (non-aqueous)

METHOD

Assign ox numbers; find electrons lost (reducing agent) and gained (oxidizing agent); scale by the LCM so total lost = total gained; balance the rest by inspection; reduce. Best when no H⁺/OH⁻/H₂O is needed.