

Rules For Assigning Oxidation States

- For free elements the oxidation state is zero.
e.g. Fe(s), O₂(g), O₃(g), H₂(g), Hg(l), Hg(g), S(s) etc.
- For monoatomic ions, the oxidation state is given by the charge on the ion.
e.g. Cl⁻ (-1), Fe²⁺ (+2), Fe³⁺ (+3), S²⁻ (-2), Ca²⁺ (+2), H⁺ (+1) etc
- Certain elements when present in compounds have common oxidation states.
 - alkali metals (Li⁺, Na⁺, K⁺) are always +1
 - alkali earth metals (Mg²⁺, Ca²⁺, Sr²⁺, Ba²⁺) are always +2
 - hydrogen is +1 (except in metal hydride compounds such as LiH)
 - oxygen is -2 (except in peroxides such as H₂O₂)
 - halogens (F⁻, Cl⁻, Br⁻, I⁻) are usually -1 (exceptions include interhalogen compounds e.g., in ClF₇, chlorine is +7 and fluorine is -1 and oxyanions e.g., in ClO₃⁻ chlorine is +5)
- The sum of the oxidation states in a molecule is zero.
e.g. H₂O (+1) + (+1) + (-2) = 0 Fe(OH)₂ (+2) + 2(-2) + 2(+1) = 0
- The sum of the oxidation states in an ion is equal to the charge on the ion.
e.g. OH⁻ (-2) + (+1) = -1 SO₄²⁻ (+6) + 4(-2) = -2

Note: Oxidation corresponds to an increase in the oxidation state and reduction corresponds to a decrease in the oxidation state.

Sample Exercises:

- Determine the oxidation states for all of the atoms in each of the following:
 - NO₃⁻, NH₃, NH₄⁺, N₂
 - Na₂S, Na₂SO₃, Na₂S₂O₃, Na₂SO₄
 - ClO₄⁻, ClO₃⁻, ClO₂⁻, ClO⁻
 - CO₂, H₂CO₃, C₂H₅OH, CH₃CHO
- Indicate whether the following processes involve oxidation or reduction
 - SO₄²⁻ ---> H₂S
 - NH₄⁺ ---> NO₃
 - NaClO -----> Cl⁻
 - 2 Cu⁺ -----> Cu²⁺ + Cu
- In the following reactions identify the species that is oxidised and that being reduced.
 - IO₄⁻ + I⁻ + H⁺ ---> I₂ + H₂O
 - NO₃⁻ + H⁺ + Cl⁻ ---> NO + Cl₂ + H₂O
 - NO₃⁻ + Cu + H⁺ ---> NO₂ + Cu²⁺ + H₂O