

Solubility Rules

The solubility rules given below are for *ionic compounds* or *salts*. Therefore, these rules do not apply to molecular compounds such as acids, e.g., HCl, H₂S, H₂SO₄, HC₂H₃O₂, etc. or organic compounds, e.g., C₂H₅OH. A *soluble ionic compound* dissolves to a significant extent in water and is generally defined as having a solubility in water of > 0.1 M. An *insoluble ionic compound* does not dissolve to a significant extent in water and is generally defined as having a solubility in water of < 0.1 M. Please note that the 0.1 M dividing line, between soluble and insoluble, is a man-made rule, i.e., not a fundamental law of nature. Therefore, ionic compounds with intermediate solubilities, i.e., near the 0.1 M limit, may be classified as soluble in one source but insoluble in another source. In this presentation, ionic compounds with intermediate solubilities will be specified as *sparingly soluble*.

Use the solubility rules in the order given. Once a rule is found that applies to either the anion or the cation of a salt, do not proceed further through the rules. Use that rule to predict the solubility of the salt.

Solubility Rules for Ionic Compounds (Salts) in Water

1. Ionic compounds that contain **Group IA metal cations** (Na⁺, K⁺, Li⁺ etc.) or **ammonium cations**, NH₄⁺, are **soluble**.
2. Ionic compounds that contain **NO₃⁻, NO₂⁻, ClO₃⁻, ClO₄⁻, C₂H₃O₂⁻, or HCO₃⁻** anions are **soluble**. (NOTE: AgNO₂ is sparingly soluble.)
3. Ionic compounds that contain **Cl⁻, Br⁻, or I⁻** anions are **soluble except** when combined with **Ag⁺, Hg₂⁺², or Pb⁺²** cations.
4. Ionic compounds that contain **SO₄⁻²** anions are **soluble except** when combined with **Ag⁺, Hg₂⁺², Pb⁺², Ba⁺², Ca⁺², or Sr⁺²** cations. (NOTE: Ag₂SO₄ and CaSO₄ are sparingly soluble.)
5. Most ionic compounds that contain **S⁻²** anions are **insoluble** except when combined with a Group IA or IIA metal cations or NH₄⁺.
6. Most ionic compounds that contain **OH⁻, O⁻², CO₃⁻², PO₄⁻³, CrO₄⁻², or Cr₂O₇⁻²** anions are **insoluble** except when combined with a Group IA metal cations or NH₄⁺. (NOTE: Ca(OH)₂, Sr(OH)₂, and Ba(OH)₂ are sparingly soluble but are strong bases and therefore strong electrolytes.)