Solubility Rules for Ionic Compounds in Water

Compounds Containing the Following lons Are Generally <u>Soluble</u>	Exceptions
Li+, Na+, K+, and NH ₄ +	None
NO ₃ -, CH ₃ COO-	None
CI-, Br-, and I-	When these ions pair with Ag+, Hg ₂ ²⁺ , or Pb ²⁺ => insoluble compounds
SO ₄ ² -	When SO ₄ ²⁻ pairs with Ca ²⁺ , Sr ²⁺ , Ba ²⁺ , Pb ²⁺ , or Ag ⁺ => insoluble

Compounds Containing the Following Ions Are Generally <i>Insoluble</i>	Exceptions
OH- and S ²⁻	When these ions pair with Li+, Na+, K+, or NH ₄ + => soluble
	When S ²⁻ pairs with Ca ²⁺ , Sr ²⁺ or Ba ²⁺ => soluble
	When OH- pairs with Ca ²⁺ , Sr ²⁺ or Ba ²⁺ => slightly soluble
CO ₃ ² - and PO ₄ ³ -	When these ions pair with Li⁺, Na⁺, K⁺, or NH₄⁺ => soluble

PbCl2 not soluble
Cucl2 soluble
Cucl2 soluble
Ca CNO3)2 soluble
Ba Soy insoluble

Nis insoluble

Mg3 CPO4)2 insoluble

Liz CO3 soluble

NH4Ce soluble

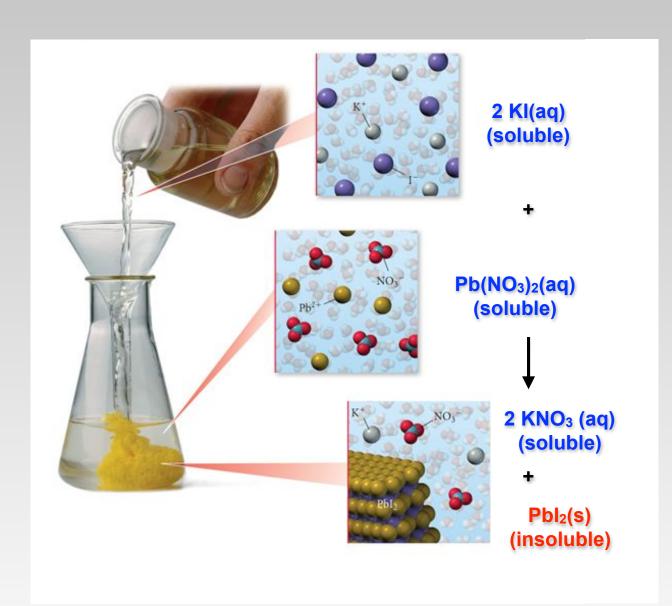
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Hard Water: $Ca^{2+}Caq$) and $Mg^{2+}(aq)$ => odd Na_2Co_3 to Caundry clebegent: $Ca^{2+}(aq) + Co_3^{2-}(aq) \rightarrow Ca Co_3(s)$ $Mg^{2+}(aq) + Co_3^{2-}(aq) \rightarrow Mg Co_3(s)$

Precipitation Reaction



$$2KI(aq) + Pb(NO_3)_2(aq) \rightarrow 2KNO_3(aq) + PbI_2(s)$$
In contrast:
$$2KI(aq) + 2NaNO_3(aq) \rightarrow no \ reaction$$

$$K^+(aq) + NO_3(aq) \rightarrow no \ reaction$$

$$Na^+(aq) + I^-(aq) \rightarrow no \ reaction$$

$$Na^+(aq) + I^-(aq) \rightarrow no \ reaction$$

Examples of Precipitation Reaction

Write an equation for the precipitation reaction that occurs (if any) when solutions of potassium carbonate and nickel(II)chloride are mixed.

- 1. Write the formulas of the two compounds being mixed as reactants in a chemical equation
- 2. Below the equation, write the formulas of the products that could form for the reactants (cation + anion). Make sure to write correct formulas.
- 3. Refer to the solubility rules to determine whether any of the possible products are insoluble
- 4. If all of the possible products are soluble, there will be no precipitate. Write "No Reaction" after the arrow.
- 5. If any of the possible products are insoluble, write their formulas as the products of the reaction, using (s) to indicate solid. Write any soluble products with (aq) to indicate aqueous.
- 6. Balance the equation

Molecular, Complete Ionic and Net Ionic Equation

Molecular Equation: Chemical equation showing the complete, neutral formulas for every compound in the reaction.

$$Pb(NO_3)_2(aq) + 2KCl(aq) \rightarrow PbCl_2(s) + 2KNO_3(aq)$$

<u>Complete Ionic Equation:</u> Chemical equation showing all the species as they are actually present in solution.

$$Pb^{2+}(aq) + 2NO_3^-(aq) + 2K^+(aq) + 2Cl^-(aq) \rightarrow PbCl_2(s) + 2K^+(aq) + 2NO_3^-(aq)$$

Net Ionic Equation: Equation showing only the species that actually change during the reaction.

$$Pb^{2+}(aq) + 2NO_3^{-}(aq) + 2K^{+}(aq) + 2Cl^{-}(aq) \rightarrow PbCl_2(s) + 2K^{+}(aq) + 2NO_3^{-}(aq)$$
Spectator lons

$$Pb^{2+}(aq) + 2Cl^{-}(aq) \rightarrow PbCl_{2}(s)$$

SrClz Caq) + Liz PoyCaq) -> SrzCPOy)(s) + Lice (aq)
Balanced Molecular Formula
3Srclz Caq) + 2Liz PoyCaq) -> SrzCPOy)(s) + 6Lice(aq)

Complete lonie Equation

Net ionic equation

Spectrator lous: Li^{\dagger} , Ce^{-} $3sr^{2\uparrow}(aq) + 2P0y^{3}-Caq) \longrightarrow Sr_3CP0y)_2(s)$

Example 21 Acid/Base reaction Unbalanced: HI (aq) + BacoH), (aq) -> H20(e) + Balz (aq) base water solt Molecular Equation 241 (ag) + Ba coH), (ag) -> 2420(e) + Balz (ag) Complete louic 2H+(aq)+21-Caq)+Bo2r(aq)+20H-Caq) -> 2420(e) + Ba24(ag) + 21 (ag)

Net lowic:
Spectator: Bot, 1

2H+Caq) + 20H-Caq) -> 2H20(e)

Example 3

2AgNo3 (aq) 2 Mg (le caq) -> 2Ag (e (s) + Mg(No3)2 (aq)
Complete louic:

$$2Ag^{\dagger}(cog) + 2Nv_3^{-}(cog) + Mg^{\prime\prime}(cog) + 2ce^{-}(cog) - >$$

 $2Ag(ce(s)) + Mg^{\prime\prime}(cog) + 2Nv_3^{-}(cog)$

Net louic

249+ (aq) + 2 Ce - (aq) -> 249 Ce (s)