

Concentration of Ions in Solution
[0.1 mole of substance in 1 L water]

	Strong Electrolyte Completely dissociate in solution	Weak Electrolyte Partially dissociate in solution
Soluble	<u>Large concentration</u> Strong acids/bases Salts of soluble ions* $\text{HCl} \rightarrow \text{H}^+ + \text{Cl}^-$ (acid) $\text{NaOH} \rightarrow \text{Na}^+ + \text{OH}^-$ (base) $\text{KNO}_3 (\text{s}) \rightarrow \text{K}^+ + \text{NO}_3^-$ (neutral) $(\text{NH}_4)_2\text{SO}_4 (\text{s}) \rightarrow 2\text{NH}_4^+ + \text{SO}_4^{2-}$ (neutral ¹)	<u>Small Concentration</u> Weak acids/bases $\text{HOAc} \rightleftharpoons \text{H}^+ + \text{OAc}^-$ (acid) $\text{HF} \rightleftharpoons \text{H}^+ + \text{F}^-$ (acid) $\text{NH}_3 + \text{H}_2\text{O} \rightleftharpoons \text{NH}_4^+ + \text{OH}^-$ (base) $\text{py} + \text{H}_2\text{O} \rightleftharpoons \text{pyH}^+ + \text{OH}^-$ (base ³)
Sparingly Soluble	<u>Small Concentration</u> Salts of insoluble ions* $\text{CaCO}_3 (\text{s}) \rightleftharpoons \text{Ca}^{2+} + \text{CO}_3^{2-}$ (basic ²) $\text{Fe}(\text{OH})_3 (\text{s}) \rightleftharpoons \text{Fe}^{3+} + 3 \text{OH}^-$ $\text{AgCl} (\text{s}) \rightleftharpoons \text{Ag}^+ + \text{Cl}^-$	<u>Very Small Concentration</u> Most uncharged organic acids/bases

Strong Acids: HCl, HBr, HI, HClO₄, HNO₃, H₂SO₄ (but pK_{a2} = 1.89)

Soluble Strong Bases: LiOH, NaOH, KOH, RbOH, CsOH, [R₄N]OH (R=methyl, ethyl, etc.)

Moderately Soluble Strong Bases: Ca(OH)₂, Sr(OH)₂, Ba(OH)₂

***Table 4.1** Solubility Guidelines for Common Ionic Compounds in Water

Soluble Ionic Compounds	Important Exceptions
NO ₃ ⁻ , ClO ₃ ⁻ , ClO ₄ ⁻	
C ₂ H ₃ O ₂ ⁻ (OAc ⁻), acetate	AgOAc is moderately soluble
Cl ⁻ , Br ⁻ , I ⁻	Pb ²⁺ , Ag ⁺ , Hg ₂ ²⁺
SO ₄ ²⁻	Sr ²⁺ , Ba ²⁺ , Pb ²⁺ , Hg ₂ ²⁺ CaSO ₄ , Ag ₂ SO ₄ are moderately soluble
Li ⁺ , Na ⁺ , K ⁺ , Rb ⁺ , Cs ⁺ , NH ₄ ⁺	LiF is moderately soluble
Insoluble Ionic Compounds	Important Exceptions
CO ₃ ²⁻ , PO ₄ ³⁻ , CrO ₄ ²⁻	Alkali metals, NH ₄ ⁺
OH ⁻	Alkali metals, Ca(OH) ₂ , Sr(OH) ₂ , Ba(OH) ₂ are moderately soluble
S ²⁻	Alkali metals, NH ₄ ⁺ , Ca ²⁺ , Sr ²⁺ , Ba ²⁺

Precedence: Li⁺, Na⁺, K⁺, Rb⁺, Cs⁺, NH₄⁺, Cl⁻, Br⁻, I⁻, OAc⁻, NO₃⁻, SO₄²⁻, ClO₃⁻, ClO₄⁻ take precedence over the other ions. For example, (NH₄)₂S is soluble and a strong electrolyte.

Strong Electrolytes: Essentially all ionic compounds and the strong acids. (Example: BaCO₃)

Weak Electrolytes: Molecular compounds that partially dissociate, which are primarily weak acids and bases. The weak acids include most all acids, and the weak bases include all the non-hydroxide bases.

Notes: 1. $(\text{NH}_4)_2\text{SO}_4 (\text{s}) \rightarrow 2\text{NH}_4^+ + \text{SO}_4^{2-}$ with some $\text{NH}_4^+ + \text{SO}_4^{2-} \rightleftharpoons \text{NH}_3 + \text{HSO}_4^-$

2. $\text{CaCO}_3 (\text{s}) \rightleftharpoons \text{Ca}^{2+} + \text{CO}_3^{2-}$ with some $\text{H}_2\text{O} + \text{CO}_3^{2-} \rightleftharpoons \text{OH}^- + \text{HCO}_3^-$

3. py = pyridine as just one example of an organic non-hydroxide base.