CHEMWHIZ QUICK REFERENCE

TOPIC 24

Solubility & Complex-Ion Equilibria

Ksp, molar solubility, the common-ion effect, Q vs Ksp, selective precipitation, and coupled equilibria.

01 Ksp expression — CORE RULE

Ksp = product of ion concentrations, each to its coefficient, in a saturated solution. The pure solid is excluded. $AgCl \rightleftharpoons Ag^{+} + Cl^{-}$: $K_{sp} = [Ag^{+}][Cl^{-}]$.

02 Ksp in terms of solubility s — REFERENCE

Salt type	Ksp
MX	s^2
MX_2 or M_2X	$4s^3$
MX_3 or M_3X	$27s^4$
M_2X_3	$108s^5$

03 Molar solubility from Ksp — METHOD

ICE with x for the reference ion, write the Ksp polynomial, solve for x. If solubility is given in g/L, convert to mol/L (÷ molar mass) before using Ksp.

04 Insoluble hydroxides & pH — CORE RULE

For $M(OH)_n$, $[OH^-] = n \cdot s$, so $pOH = -\log[OH^-]$, $pH = 14 - pOH$. Given pH instead: $[OH^-] = 10^{(-(14-pH))}$, then solve Ksp for the metal-ion concentration.

05 Common-ion effect — CORE RULE

A shared ion already in solution goes into the ICE initial row, lowering molar solubility vs pure water. The x-small approximation ($x \ll$ common-ion concentration) is usually valid; check $x < 5\%$.

06 Q vs Ksp (will it precipitate?) — CORE RULE

Compute Q from initial ion concentrations (apply dilution when mixing: [ion] × V_part/V_total). $Q < K_{sp} \rightarrow$ no precipitate; $Q > K_{sp} \rightarrow$ precipitates until $Q = K_{sp}$; $Q = K_{sp} \rightarrow$ just saturated.

07 Selective precipitation — CORE RULE

Find the counter-ion concentration each salt needs to hit $Q = K_{sp}$; the lowest threshold precipitates first. Comparing Ksp values directly is valid only for the same salt stoichiometry.

08 Complex-ion / coupled equilibria — CORE RULE

Coupling dissolution to complex formation raises solubility: $K_{overall} = K_{sp} \times K_f$. E.g. $Al(OH)_3(s) + OH^- \rightleftharpoons Al(OH)_4^-$. With excess ligand ($[L] \approx [L]_0$), a 1:1 salt gives $s = \sqrt{(K_{overall} \cdot [L]^j)}$. Acid-coupled $M(OH)_n$: $K = K_{sp}/K_w^n$.