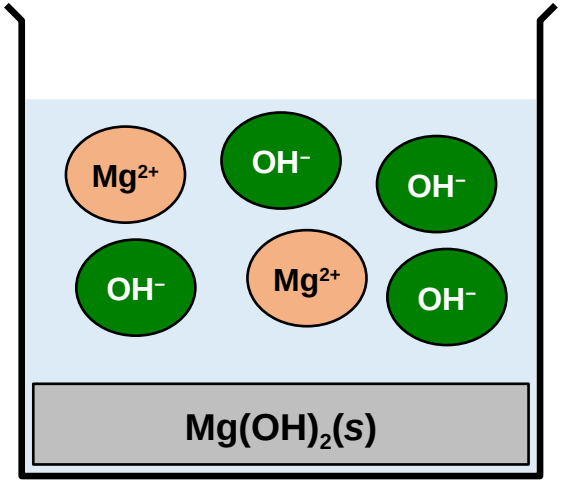
Essential Question

How can pH change how much a salt dissolves?

Solubility Equilibrium Review

- Saturated: excess solid remains
- Dissolving rate = precipitating rate
- Le Châtelier's principle still applies

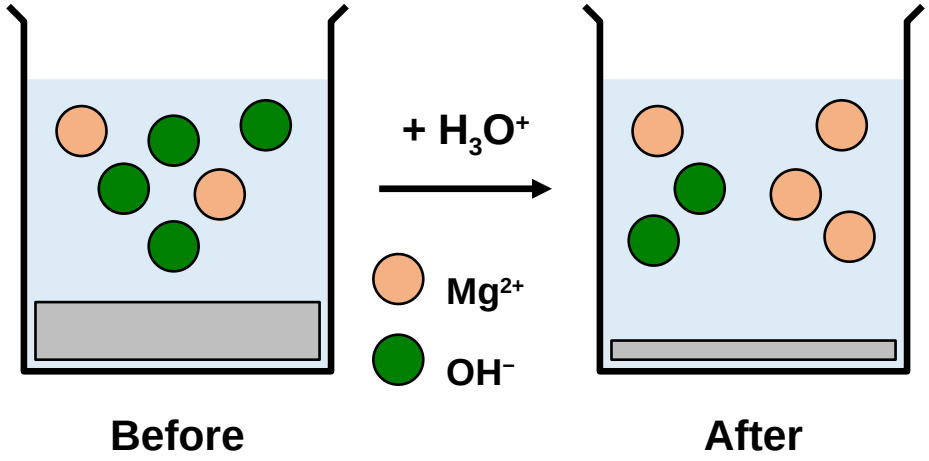


Saturated $Mg(OH)_2$

$$Mg(OH)_2(s) \rightleftharpoons Mg^{2+}(aq) + 2OH^-(aq)$$

Adding Acid to a Hydroxide

- $H_3O^+ + OH^- \rightarrow 2H_2O$
- Fewer OH^-, so it shifts right
- More $Mg(OH)_2$ dissolves



$$Mg(OH)_2(s) \rightleftharpoons Mg^{2+}(aq) + 2OH^-(aq)$$

Shift right

Anions from Weak Acids

- These anions are weak bases
- H_3O^+ turns them into weak acids
- Their salts dissolve more in acid

F^- from HF	**CO_3^{2-}** from HCO_3^-
PO_4^{3-} from HPO_4^{2-}	**CH_3COO^-** from CH_3COOH

$$CaF_2(s) \rightleftharpoons Ca^{2+}(aq) + 2F^-(aq)$$

$$F^-(aq) + H_3O^+(aq) \longrightarrow HF(aq) + H_2O(l)$$

Anions from Strong Acids

- These anions are not bases
- H_3O^+ has nothing to react with
- pH has little effect on solubility

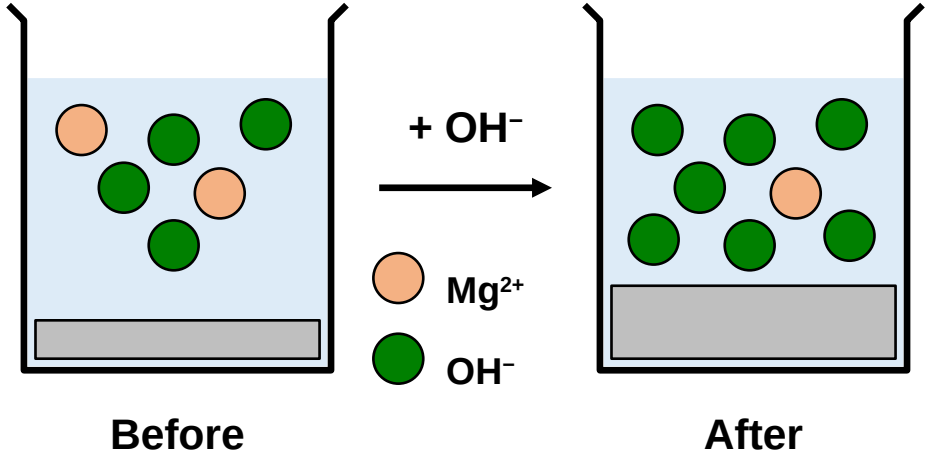
Cl^- from HCl	**Br^-** from HBr
I^- from HI	**NO_3^-** from HNO_3

$$AgCl(s) \rightleftharpoons Ag^+(aq) + Cl^-(aq)$$

Cl^- + H_3O^+: no reaction, no shift

Adding Base

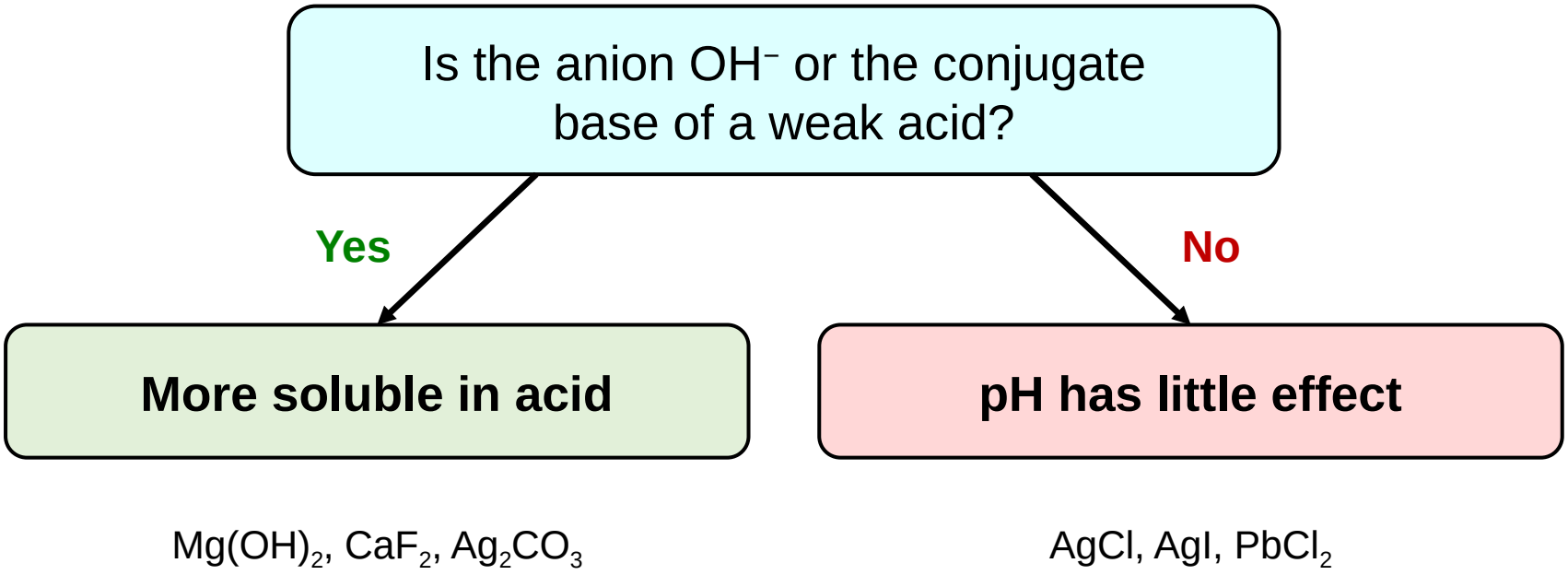
- Add OH^-, a common ion
- Equilibrium shifts left
- Less $Mg(OH)_2$ dissolves



$$Mg(OH)_2(s) \rightleftharpoons Mg^{2+}(aq) + 2OH^-(aq)$$

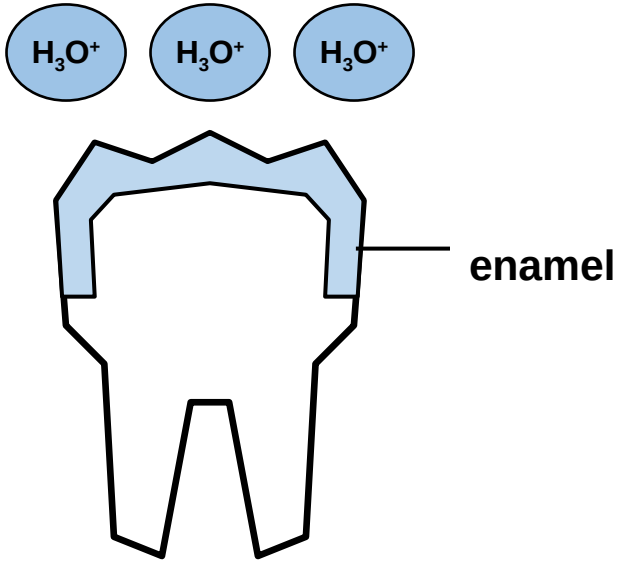
Shift left

Quick Rule


Is the anion OH^- or the conjugate base of a weak acid?
Yes
No
More soluble in acid
pH has little effect
$Mg(OH)_2$, CaF_2, Ag_2CO_3
AgCl, AgI, $PbCl_2$

Real World: Tooth Enamel

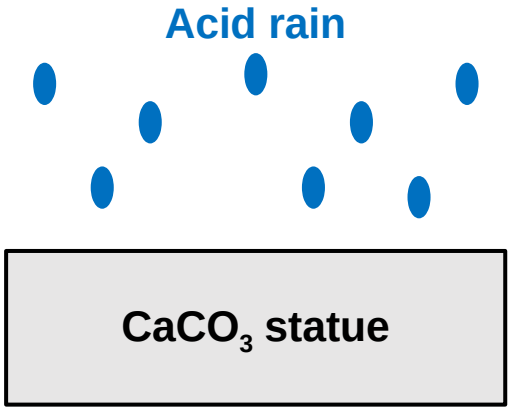
- Enamel is hydroxyapatite
- Contains basic OH^- and PO_4^{3-}
- Acidic drinks dissolve enamel



$$Ca_5(PO_4)_3OH(s) \rightleftharpoons 5Ca^{2+}(aq) + 3PO_4^{3-}(aq) + OH^-(aq)$$

Real World: Limestone

- Limestone and marble are $CaCO_3$
- Acid rain removes CO_3^{2-}
- The stone slowly dissolves

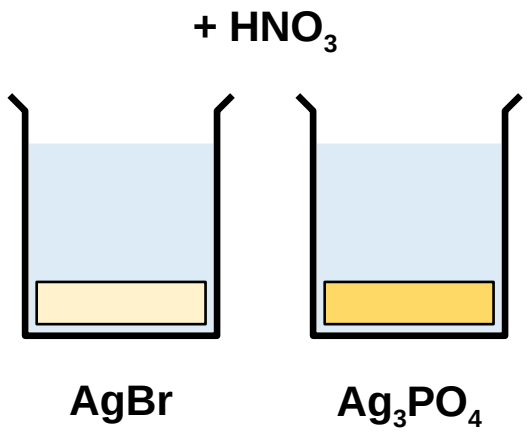


$$CaCO_3(s) \rightleftharpoons Ca^{2+}(aq) + CO_3^{2-}(aq)$$

$$CO_3^{2-}(aq) + 2H_3O^+(aq) \longrightarrow CO_2(g) + 3H_2O(l)$$

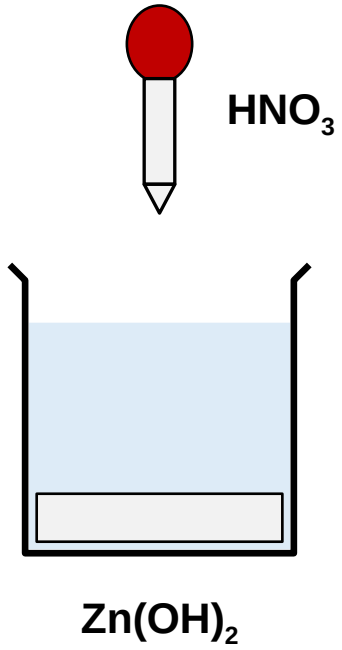
Example: $AgBr$ vs. Ag_3PO_4

Solid AgBr and solid Ag_3PO_4 are each added to water, and then HNO_3 is added. Which salt's solubility increases? Justify your answer.



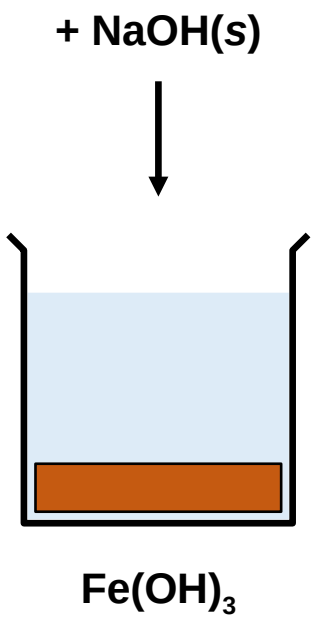
Example: Acid and $Zn(OH)_2$

A few drops of HNO_3 are added to a saturated solution of $Zn(OH)_2$ with excess solid. Predict the effect on the amount of solid and on $[Zn^{2+}]$. Justify.



Example: Base and $Fe(OH)_3$

Solid NaOH is added to a saturated solution of $Fe(OH)_3$ with excess solid. Predict the effect on the solubility of $Fe(OH)_3$. Justify.

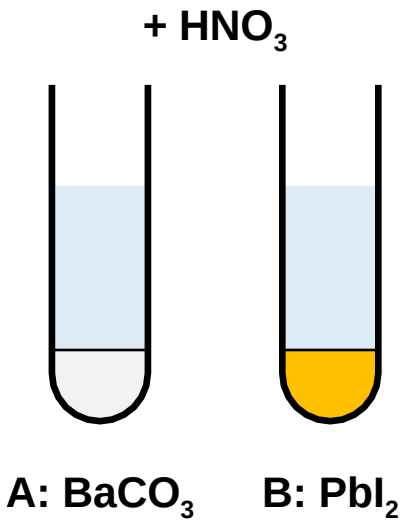


Example: Two Test Tubes

Tube A holds excess solid $BaCO_3$ in water.

Tube B holds excess solid PbI_2 in water.

Dilute HNO_3 is added to each tube. Predict what you observe in each tube. Justify.



Big Ideas

- Acid removes basic anions
- Strong acid anions: little pH effect
- Added OH^-: hydroxides dissolve less

More soluble in acid
$Mg(OH)_2$, CaF_2, Ag_2CO_3

pH has little effect
AgCl, AgI, $PbCl_2$

Next up: Unit 9, Thermodynamics and Electrochemistry