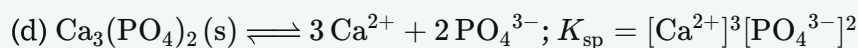
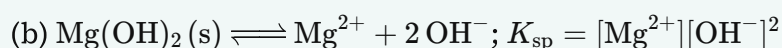


Solubility Equilibria

Answer key with worked solutions

A. Expressions

1. K_{sp} expressions.



B. Molar solubility

2. BaSO₄.

$$s = \sqrt{1.1 \times 10^{-10}} = 1.0 \times 10^{-5} \text{ mol/L}; 1.0 \times 10^{-5} \text{ mol/L} \times 233.39 \text{ g/mol} = 2.4 \times 10^{-3} \text{ g/L}$$

3. Mg(OH)₂.

$$(a) K_{\text{sp}} = 4s^3, \text{ so } s = \sqrt[3]{\frac{1.8 \times 10^{-11}}{4}} = 1.7 \times 10^{-4} \text{ mol/L}$$

$$(b) [\text{OH}^-] = 2s = 2 \times 1.65 \times 10^{-4} = 3.3 \times 10^{-4} \text{ mol/L}$$

$$(c) \text{pOH} = -\log(3.30 \times 10^{-4}) = 3.48; \text{pH} = 14.00 - 3.48 = 10.52$$

4. Ag₂CrO₄.

$$[\text{Ag}^+] = 2s, [\text{CrO}_4^{2-}] = s; K_{\text{sp}} = (2s)^2s = 4s^3 = 4 \times (6.5 \times 10^{-5})^3 = 1.1 \times 10^{-12}$$

5. Comparing.

AgCl: $s = \sqrt{1.8 \times 10^{-10}} = 1.3 \times 10^{-5} \text{ mol/L}$. Ag₂CrO₄: $s = 6.5 \times 10^{-5} \text{ mol/L}$, **five times larger**. Their K_{sp} formulas differ (s^2 versus $4s^3$), so K_{sp} values can only be compared directly for salts with the same ion ratio.

C. Common ion and precipitation

6. CaF_2 in NaF .

$[\text{F}^-] \approx 0.010 \text{ mol/L}$; $K_{\text{sp}} = s(0.010)^2$, so $s = \frac{3.9 \times 10^{-11}}{1.0 \times 10^{-4}} = 3.9 \times 10^{-7} \text{ mol/L}$, about **550 times less** than in pure water.

7. Mixing.

Total volume 50.0 mL.

$$[\text{Ba}^{2+}] = 0.010 \text{ mol/L} \times \frac{10.0 \text{ mL}}{50.0 \text{ mL}} = 2.0 \times 10^{-3} \text{ mol/L}$$

$$[\text{SO}_4^{2-}] = 0.0050 \text{ mol/L} \times \frac{40.0 \text{ mL}}{50.0 \text{ mL}} = 4.0 \times 10^{-3} \text{ mol/L}$$

$Q = (2.0 \times 10^{-3})(4.0 \times 10^{-3}) = 8.0 \times 10^{-6}$, far greater than $K_{\text{sp}} = 1.1 \times 10^{-10}$: **BaSO_4 precipitates.**

D. Challenge

8. Milk of magnesia.

$\text{Mg}(\text{OH})_2(\text{s}) \rightleftharpoons \text{Mg}^{2+} + 2 \text{OH}^-$. Stomach acid supplies H^+ , which removes OH^- by forming water ($\text{H}^+ + \text{OH}^- \rightarrow \text{H}_2\text{O}$). By Le Chatelier's principle, the equilibrium shifts to the **right** to replace the OH^- , so more $\text{Mg}(\text{OH})_2$ dissolves, neutralizing the acid.