

April 3, 2002

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- **Exam #3**: 2 weeks from today!
- **JDHP**: Applications due April 26
- Demo Friday
- Quiz Friday

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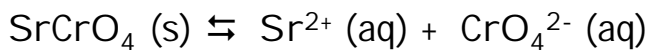
# Solubility Equilibria

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Chem 36  
Spring 2002

## Definitions

- "Insoluble" ionic solids are *actually sparingly soluble*:



$$K_{\text{sp}} = [\text{Sr}^{2+}][\text{CrO}_4^{2-}] = 4.0 \times 10^{-5}$$

solubility product constant

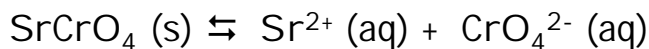
**$K_{\text{sp}}$  and solubility are NOT the same!**

- **Solubility:** amount (*moles* or *grams*) of a compound that is soluble in **1.00 L** of solution.

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## Calculating Solubility

- **What is the solubility of  $\text{SrCrO}_4$ ?**



**Equilib:**                                    **S**                                    **S**

Plugging into  $K_{\text{sp}}$ :

$$K_{\text{sp}} = [\text{Sr}^{2+}][\text{CrO}_4^{2-}] = \mathbf{S^2} = 4.0 \times 10^{-5}$$

$$\mathbf{S = 6.3 \times 10^{-3} \text{ mol SrCrO}_4/\text{L}}$$

molar solubility

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## Gram Solubility?

- Convert *molar* solubility to **mass**:

$$\frac{6.325 \times 10^{-3} \text{ mol SrCrO}_4}{\text{L}} \times \frac{203.61 \text{ g SrCrO}_4}{\text{mol SrCrO}_4} = 1.29 \frac{\text{g SrCrO}_4}{\text{L}}$$

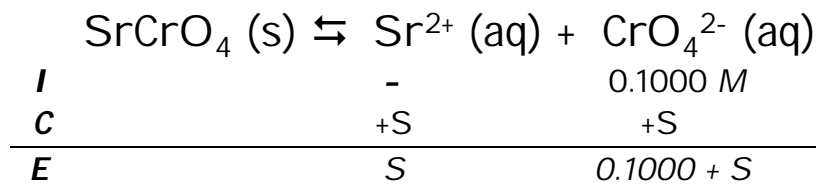
$$= \underline{1.3 \text{ g SrCrO}_4/\text{L}}$$

How would a common ion affect solubility?

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## Common Ion Effect

- What is the solubility of SrCrO<sub>4</sub> in 0.1000 M K<sub>2</sub>CrO<sub>4</sub>?



$$K_{\text{sp}} = [\text{Sr}^{2+}][\text{CrO}_4^{2-}] = \mathbf{S(0.1000 + S)} = 4.0 \times 10^{-5}$$

Assume:  $S \ll 0.1000 \Rightarrow S' (0.1000) = 4.0 \times 10^{-5}$

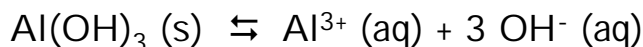
$$S' = \underline{4.0 \times 10^{-4} \text{ M}} \text{ (assumption checks!)}$$

$$\underline{= 8.1 \times 10^{-2} \text{ g SrCrO}_4/\text{L}}$$

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## More Common Ions

- Sometimes the *common ion* is one that is commonly found in water: e.g., OH<sup>-</sup>



**E**

**S**

**3S**

$$K_{\text{sp}} = [\text{Al}^{3+}][\text{OH}^-]^3 = \text{S}(3\text{S})^3 = 3.7 \times 10^{-15}$$

$$27\text{S}^4 = 3.7 \times 10^{-15}$$

$$\text{S} = \underline{\underline{1.1 \times 10^{-4} \text{ mol Al(OH)}_3/\text{L}}}$$

What about OH<sup>-</sup>?

At pH=7, [OH<sup>-</sup>]<sub>H<sub>2</sub>O</sub> << S (safe to ignore)

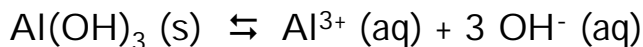
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## How 'bout at pH=12.00?

- Now we've got LOTS of OH<sup>-</sup>!

pH = 12.00, so pOH = 2.00:

$$[\text{OH}^-] = 1.0 \times 10^{-2} \text{ M}$$



**E**

**S**

**1.0 x 10<sup>-2</sup> + 3S**

$$K_{\text{sp}} = [\text{Al}^{3+}][\text{OH}^-]^3 = \text{S}(0.010 + 3\text{S})^3 = 3.7 \times 10^{-15}$$

Assume: 3S << 0.010 ⇒ S' (0.010)<sup>3</sup> = 3.7 × 10<sup>-15</sup>

$$\text{S}' = \underline{\underline{3.7 \times 10^{-9} \text{ mol Al(OH)}_3/\text{L}}} \text{ (assumption checks!)}$$

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