April 3, 2002

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

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Solubility Equilibria

Chem 36

Spring 2002

Definitions

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

$$SrCrO_4\ (s) \leftrightarrows Sr^{2+}\ (aq) + CrO_4^{2-}\ (aq)$$

$$\mathbf{K_{sp}} = [Sr^{2+}][CrO_4^{2-}] = 4.0 \times 10^{-5}$$

solubility product constant

K_{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 $SrCrO_4$?**

$$SrCrO_4\ (s) \leftrightarrows Sr^{2+}\ (aq) + CrO_4^{2-}\ (aq)$$

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

Plugging into K_{sp}:

$$K_{sp} = [Sr^{2+}][CrO_4^{2-}] = \mathbf{S^2} = 4.0 \times 10^{-5}$$

S = ***6.3 x 10^{-3}*** mol $SrCrO_4$/L

molar solubility

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Gram Solubility?

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

$$\frac{6.325 \times 10^{-3} \text{ mol } SrCrO_4}{L} \times \frac{203.61 \text{ g } SrCrO_4}{\text{mol } SrCrO_4} = 1.29 \frac{g\ SrCrO_4}{L}$$

= *1.3 g $SrCrO_4$/L*

How would a common ion affect solubility?

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Common Ion Effect

- What is the solubility of $SrCrO_4$ in *0.1000 M K_2CrO_4*?

$$SrCrO_4\ (s) \leftrightarrows Sr^{2+}\ (aq) + CrO_4^{2-}\ (aq)$$

	Sr^{2+}	CrO_4^{2-}
I	**-**	0.1000 *M*
C	+S	+S
E	*S*	*0.1000 + S*

$K_{sp} = [Sr^{2+}][CrO_4^{2-}] =$ **S(0.1000 + S)** = *4.0×10^{-5}*

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

S' = ***4.0×10^{-4} M*** *(assumption checks!)*

(= 8.1×10^{-2} g $SrCrO_4$/L)

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More Common Ions

- Sometimes the *common ion* is one that is commonly found in water: e.g., OH^-

$$Al(OH)_3\ (s) \leftrightarrows Al^{3+}\ (aq) + 3\ OH^-\ (aq)$$

E **S** **3S**

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

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

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

What about OH^-?

At pH=7, $[OH^-]_{H2O} << S$ (safe to ignore)

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How 'bout at pH=12.00?

- Now we've got LOTS of OH^-!

pH = 12.00, so pOH = 2.00:

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

$$Al(OH)_3\ (s) \leftrightarrows Al^{3+}\ (aq) + 3\ OH^-\ (aq)$$

E **S** 1.0×10^{-2} + **3S**

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

Assume: $3S << 0.010 \Rightarrow S'(0.010)^3 = 3.7 \times 10^{-15}$

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

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