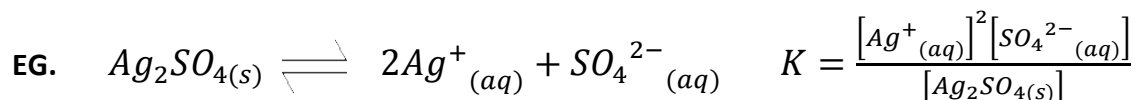


SCH 4U

SOLUBILITY EQUILIBRIUM

Many substances that are insoluble and form precipitates are actually slightly soluble in very tiny amounts in water.



Recall concentration of a ***solid is constant***; therefore, ignore this concentration.
This is known as the **SOLUBILITY PRODUCT CONSTANT**.

Therefore, $K_{sp} = [Ag^+]^2 [SO_4^{2-}]$

EG. Write the dissociation of calcium phosphate and its solubility product constant, K_{sp} .

① FIND K_{sp} GIVEN SOLUBILITY of a COMPOUND

EG. If $Ca(OH)_2$ has a solubility of 1.5×10^{-3} mol/L, calculate the K_{sp} .

EG. Lithium carbonate has a solubility of 13.0 g/L at 20°C. Calculate K_{sp} .

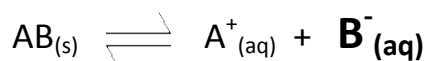
② FIND [IONS] GIVEN the K_{sp}

EG. If K_{sp} of silver sulfate is 1.2×10^{-5} , what is the concentration of silver ions and sulfate ions in a saturated solution and the molar solubility of the compound.

EG. What are the ion concentrations and the molar solubility in a saturated solution of iron (III) hydroxide if K_{sp} is 2.80×10^{-39} ?

③ THE COMMON ION EFFECT

If a solution is saturated and you add more of one of the ions (from another compound), a precipitate will occur (due to Le Chatelier's Principle).

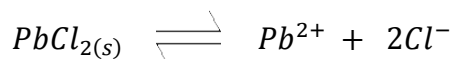


- Add more B^- -- stress is too much product, so equilibrium shifts left, producing more AB precipitate.

EG. Comparing solubility of the same compound in different solutions:

A) What is the solubility of **PbCl₂ in water**?

In K_{sp} table, $PbCl_2 = 1.7 \times 10^{-5}$ at 25°C.



$$K_{sp} = [Pb^{2+}][Cl^-]^2$$

$$1.7 \times 10^{-5} = (x)(2x)^2$$

$$1.6 \times 10^{-2} = x$$

$$\therefore [PbCl_2] = 1.6 \times 10^{-2} M$$

B) What is the solubility of **PbCl₂** in a 0.2 mol/L NaCl_(aq) solution?

	$\text{PbCl}_2 \rightleftharpoons \text{Pb}^{2+} + 2 \text{Cl}^-$	
I		0
C		+x
E		x

$$K_{sp} = [\text{Pb}^{2+}] [\text{Cl}^-]^2$$

$$1.7 \times 10^{-5} = (x) (0.2 + 2x)^2$$

ignore 2x (approximation method)

$$1.7 \times 10^{-5} = 0.04x$$

$$4.25 \times 10^{-4} = x$$

$$[\text{PbCl}_2] = 4.25 \times 10^{-4} \text{ mol/L}$$

EG. A) Determine the molar solubility of PbCrO_{4(s)} in water.

B) Determine the solubility of PbCrO_{4(s)} in 0.10 mol/L Na₂CrO_{4(aq)}.

④ BUFFERS & the COMMON ION EFFECT

- Solutions that resist changes of pH when acids or bases added.

- **weak acid** and **salt of conjugate base**

EG. HCH_3COO and NaCH_3COO

- **weak base** and **salt of conjugate acid**

EG. NH_3 and NH_4Cl

These buffers have a pH other than 7.

STEPS:

1. [acid] and [ion from salt] in buffer determined by...

$$\frac{V_{\text{initial}}}{V_{\text{total}}} \times [\text{original}] = [\text{buffer}]$$

2. dissociation equation of acid
3. ICE table
4. K_a expression
5. substitute and solve
6. $\text{pH} = -\log[\text{H}_3\text{O}^+]$

EG. What is the pH at 25°C of a buffer made by mixing equal volumes of 0.20 mol/L acetic acid solution and 0.20 mol/L sodium acetate solution?

EG. Calculate the pH if 200.0 mL of 0.10 mol/L ammonia and 150.0 mL of 0.25 mol/L ammonium chloride are mixed to form a buffer.