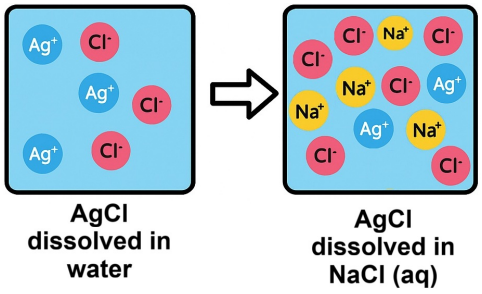
Solution Equilibria **Name**_____

Solubility and Common Ion Effects

Read from **Lesson 1c:** [Solubility and Common Ion Effects] in the **Chemistry Tutorial** Section**, Chapter 16** of **The Physics Classroom**:

What Is a Common Ion?

- A **common ion** is an ion shared between two salts.
- Example: In a solution of AgCl and NaCl, Cl^- is the common ion.



The Common Ion Effect

- Adding a common ion to a solution containing an insoluble salt **reduces the salt's solubility**.

K_{sp} Remains Constant

- The **solubility product constant (K_{sp})** does not change.
- What changes is the **amount of salt that dissolves** before equilibrium is reached.

Simplifying Common Ion Problems - Assumption

- Assume the common ion's concentration is **dominated by the soluble salt**.
- If the soluble salt provides 0.10 M of the ion, the small contribution from the insoluble salt is negligible: (0.10 + x is approx. 0.10)

Step-by-Step Guide to Solve Common Ion Problems

- **Write the dissociation equation** for the insoluble salt.
- **Write the Ksp expression**.
- **Identify the common ion** and its initial concentration.
- **Set up an ICE table** (Initial, Change, Equilibrium).
- **Apply the simplifying assumption** to reduce algebraic complexity.
- **Solve for x**, which represents the solubility.

Example: Copper(II) carbonate is an insoluble salt with a K_{sp} value of 2.5×10^{-10}. Determine its solubility in a 0.10 M solution of Na_2CO_3.

$$K_{sp} = 2.5 \times 10^{-10} = [Cu^{2+}] * [CO_3^{2-}]$$

The $CuCO_3$ is being dissolved in a solution of Na_2CO_3. This solution contains CO_3^{2-} ions; it is the common ion. The concentration of the CO_3^{2-} in this solution is initially 0.10 M.

	$CuCO_3$ (s)	⇄	Cu^{2+}(aq)	+	CO_3^{2-}(aq)
Initial	Does not matter		**0**		**0.10**
Change	**-x**		**+ x**		**+ x**
Equilibrium	Does not matter		**x**		**0.10 + x**

$K_{sp} = 2.5 \times 10^{-10} = [Cu^{2+}] * [CO_3^{2-}] = (x) * (0.10)$

$x = 2.5 \times 10^{-9}$, so the solubility of $CuCO_3$ in a solution of Na_2CO_3 is **2.5×10^{-9} M**.

Solution Equilibria

Questions

1. Why does the solubility product constant (K_{sp}) remain unchanged when a common ion is present?

2. How does Le Chatelier's Principle explain the shift in equilibrium when a common ion is added to a solution?

3. Consider a saturated solution of silver iodate.
   a. What is the molar solubility of this solution in water at 25°C? The K_{sp} of silver iodate is 3.2×10^{-8}.

   b. Silver iodate is now added to a 0.250 M solution of silver chlorate.
   - Identify the common ion and its initial molar concentration.
   - Calculate the molar solubility of silver iodate in this solution.

c. Silver iodate is now added to a 0.480 M solution of potassium iodate.
- Identify the common ion and its initial molar concentration.
- Calculate the molar solubility of silver iodate in this solution.

4. Consider a saturated solution of cobalt(II) hydroxide.
a. What is the molar solubility of this solution in water at 25°C? The K_{sp} of cobalt(II) hydroxide is 5.9×10^{-15}.

b. Cobalt(II) hydroxide is now added to a 0.525 M solution of sodium hydroxide.
- Identify the common ion and its initial molar concentration.
- Calculate the molar solubility of cobalt(II) hydroxide in this solution.

c. Cobalt(II) hydroxide is now added to a 0.314 M solution of cobalt(II) chloride.
- Identify the common ion and its initial molar concentration.
- Calculate the molar solubility of cobalt(II) hydroxide in this solution.