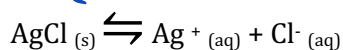


1. Common Ion Effect

Common Ion Effect

In a saturated solution, equilibrium is established between the **dissolving (increase solubility)** and **recrystallization (decrease solubility)** of a salt.

recrystallizing / ↓ solubility / shift left

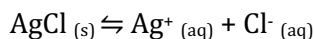


dissolving / ↑ solubility / shift right

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

⇒ Which of the following will shift this equilibrium? If it shifts, in which direction will it shift?

- ❖ Add more $\text{AgCl}_{(s)}$? } adding solids have no impact on equilibrium } no shift
- ❖ Remove $\text{AgCl}_{(s)}$? (not really an option since there is no $\text{AgCl}_{(s)}$ to remove) }
- ❖ Add $\text{Ag}^+_{(aq)}$? shift left (↓ solubility)
- ❖ Remove $\text{Ag}^+_{(aq)}$? shift right (↑ solubility)
- ❖ Add $\text{Cl}^-_{(aq)}$? shift left (↓ solubility)
- ❖ Remove $\text{Cl}^-_{(aq)}$? shift right (↑ solubility)



INCREASE the Solubility of a Salt:

- Dissolve more of the solid (if it exists)
- Equilibrium will shift to the right.
- Rate of dissolving \rightarrow Rate of recrystallization
- Can be accomplished by:

~~add reactants?~~
 ○ remove Ag^+
 ○ remove Cl^-

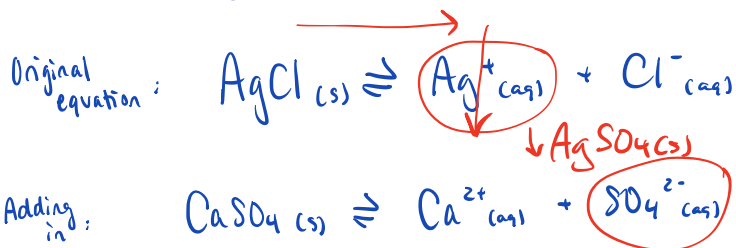
How do we REMOVE $\text{Ag}^+_{(aq)}$ or $\text{Cl}^-_{(aq)}$?

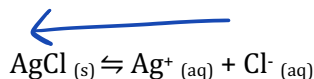
- ❖ To remove an ion from solution, we must find another ion to react with it. \rightarrow create low solubility (ppt)
- ❖ To remove Ag^+ ... SO_4^{2-} , Br^- , I^- , ~~Cl^-~~ , S^{2-} , OH^- , PO_4^{3-} , CO_3^{2-} , SO_3^{2-}
- ❖ To remove Cl^- ... Pb^{2+} , Cu^+ , ~~Ag^+~~

Which of the following salts could be added to INCREASE the solubility of AgCl ?

~~AgCl~~ CaSO_4 ~~KNO_3~~ ZnS ~~CaCl_2~~ ~~AgBr~~ Mg(OH)_2 NH_4CO_3
 ~~Ag^+ Cl^-~~ Ca^{2+} SO_4^{2-} ~~K^+ NO_3^-~~ Zn^{2+} S^{2-} ~~Ca^{2+} Cl^-~~ ~~Ag^+ Br^-~~ Mg^{2+} OH^- NH_4^+ CO_3^{2-}
 \downarrow don't want to add more Ag^+

By introducing CaSO_4 , SO_4^{2-} precipitates the Ag^+ as $\text{Ag}_2\text{SO}_4(s)$.
 This decreases $[\text{Ag}^+]$ and shifts the equilibrium to the right





DECREASE the Solubility of a Salt:

- Equilibrium will shift to the left.
- Cause more solid to form.
- Rate of dissolving < Rate of recrystallization
- Can be accomplished by:

- adding Ag^+
- adding Cl^-

~~removing reactant?~~

pair with ion that won't cause Ag^+ or Cl^- to precipitate

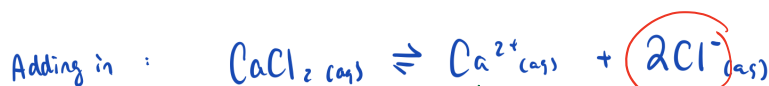
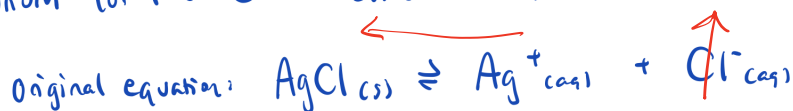
How do we ADD $\text{Ag}^+_{(aq)}$ or $\text{Cl}^-_{(aq)}$?

- ❖ Introducing another salt, which has an ion in common with the first salt, is called the "Common Ion Effect"
- ❖ To add Ag^+ ... ex. add AgNO_3
- ❖ To add Cl^- ... ex. add NaCl

Which of the following salts could be added to DECREASE the solubility of AgCl ?

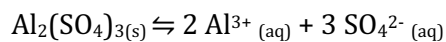
AgCl	CaSO_4	KNO_3	ZnS	CaCl_2	AgBr	Mg(OH)_2	NH_4CO_3
$\text{Ag}^+ \text{Cl}^-$	$\text{Ca}^{2+} \text{SO}_4^{2-}$	$\text{K}^+ \text{NO}_3^-$	$\text{Zn}^{2+} \text{S}^{2-}$	$\text{Ca}^{2+} \text{Cl}^-$	$\text{Ag}^+ \text{Br}^-$	$\text{Mg}^{2+} \text{OH}^-$	$\text{NH}_4^+ \text{CO}_3^-$
no				✓			

By introducing CaCl_2 , the $[\text{Cl}^-]$ is increased and therefore the equilibrium for the reaction shifts to the left



is a spectator
(won't precipitate any ions out)

1. Consider the following reaction:



If the following compounds were added,

- I. Na_2S (Na^+ spectator, S^{2-}) — Forms a ppt w/ Al^{3+} - shift right (↑ solubility)
- II. $\text{Al}_2(\text{SO}_4)_3$ (Al^{3+} , SO_4^{2-}) — no shift
- III. NaNO_3 (Na^+ spectator, NO_3^- spectator) — no shift
- IV. K_2SO_4 (K^+ spectator, SO_4^{2-}) — shift left (↓ solubility)

a) Solubility would increase:

- A. I only
- B. I & II
- C. II & IV
- D. III & IV
- E. IV only

b) Solubility would decrease:

- A. I only
- B. I & II
- C. II & IV
- D. III & IV
- E. IV only

2. Consider a solution of NaBr.

a. Write the solubility equilibrium reaction:



b. Each of the following solutions is added to the solution of NaBr. State whether each will increase or decrease the solubility. Order the solutions in order of decreasing solubility.

	Na^+ Cl^-	Ag^+ NO_3^- $\text{AgBr}(\text{s})$	K^+ NO_3^-	Na^+ SO_4^{2-}	Ag^+ NO_3^- $\text{AgBr}(\text{s})$
	1.0 M NaCl	1.0 M AgNO_3	1.0 M KNO_3	1.0 M Na_2SO_4	2.0 M AgNO_3
Increase or decrease solubility?	↓ sol.	↑ sol.	no change	↓ sol.	↑ sol.

2.0M AgNO_3 1.0M AgNO_3 1.0M KNO_3 1.0M NaCl 1.0M Na_2SO_4

Increase solubility

Decrease solubility