

## Solubility Rules for Ionic Compounds in Water

Compounds Containing the Following Ions Are Generally <i>Soluble</i>	Exceptions
$\text{Li}^+$ , $\text{Na}^+$ , $\text{K}^+$ , and $\text{NH}_4^+$	None
$\text{NO}_3^-$ , $\text{CH}_3\text{COO}^-$	None
$\text{Cl}^-$ , $\text{Br}^-$ , and $\text{I}^-$	When these ions pair with $\text{Ag}^+$ , $\text{Hg}_2^{2+}$ , or $\text{Pb}^{2+}$ => insoluble compounds
$\text{SO}_4^{2-}$	When $\text{SO}_4^{2-}$ pairs with $\text{Ca}^{2+}$ , $\text{Sr}^{2+}$ , $\text{Ba}^{2+}$ , $\text{Pb}^{2+}$ , or $\text{Ag}^+$ => insoluble

Compounds Containing the Following Ions Are Generally <i>Insoluble</i>	Exceptions
$\text{OH}^-$ and $\text{S}^{2-}$	When these ions pair with $\text{Li}^+$ , $\text{Na}^+$ , $\text{K}^+$ , or $\text{NH}_4^+$ => soluble
	When $\text{S}^{2-}$ pairs with $\text{Ca}^{2+}$ , $\text{Sr}^{2+}$ or $\text{Ba}^{2+}$ => soluble
	When $\text{OH}^-$ pairs with $\text{Ca}^{2+}$ , $\text{Sr}^{2+}$ or $\text{Ba}^{2+}$ => slightly soluble
$\text{CO}_3^{2-}$ and $\text{PO}_4^{3-}$	When these ions pair with $\text{Li}^+$ , $\text{Na}^+$ , $\text{K}^+$ , or $\text{NH}_4^+$ => soluble

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$\text{PbCl}_2$  not soluble

$\text{NiS}$  insoluble

$\text{CuCl}_2$  soluble

$\text{Mg}_3(\text{PO}_4)_2$  insoluble

$\text{Ca}(\text{NO}_3)_2$  soluble

$\text{Li}_2\text{CO}_3$  soluble

$\text{BaSO}_4$  insoluble

$\text{NH}_4\text{Cl}$  soluble

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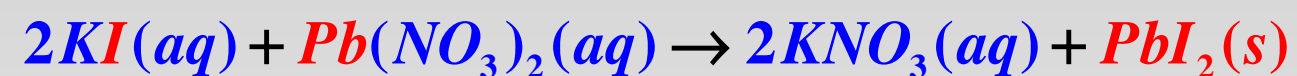
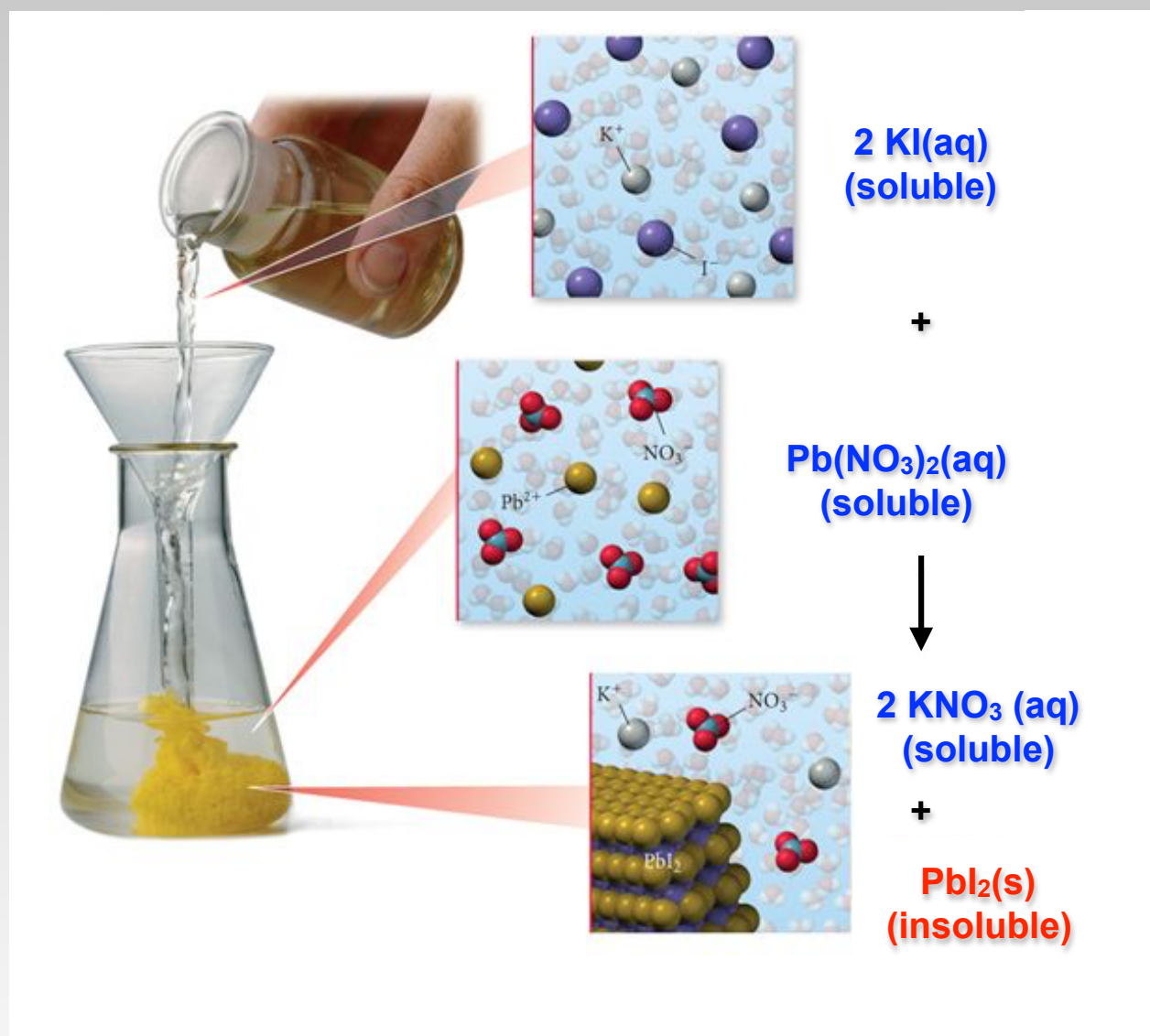
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$\text{NO}_3^-$ , $\text{CH}_3\text{COO}^-$	None
$\text{Cl}^-$ , $\text{Br}^-$ , and $\text{I}^-$	When these ions pair with $\text{Ag}^+$ , $\text{Hg}_2^{2+}$ , or $\text{Pb}^{2+} \Rightarrow$ insoluble compounds
$\text{SO}_4^{2-}$	When $\text{SO}_4^{2-}$ pairs with $\text{Ca}^{2+}$ , $\text{Sr}^{2+}$ , $\text{Ba}^{2+}$ , $\text{Pb}^{2+}$ , or $\text{Ag}^+ \Rightarrow$ insoluble

Compounds Containing the Following Ions Are Generally <i>Insoluble</i>	Exceptions
$\text{OH}^-$ and $\text{S}^{2-}$	When these ions pair with $\text{Li}^+$ , $\text{Na}^+$ , $\text{K}^+$ , or $\text{NH}_4^+ \Rightarrow$ soluble
	When $\text{S}^{2-}$ pairs with $\text{Ca}^{2+}$ , $\text{Sr}^{2+}$ or $\text{Ba}^{2+} \Rightarrow$ soluble
	When $\text{OH}^-$ pairs with $\text{Ca}^{2+}$ , $\text{Sr}^{2+}$ or $\text{Ba}^{2+} \Rightarrow$ slightly soluble
$\text{CO}_3^{2-}$ and $\text{PO}_4^{3-}$	When these ions pair with $\text{Li}^+$ , $\text{Na}^+$ , $\text{K}^+$ , or $\text{NH}_4^+ \Rightarrow$ soluble

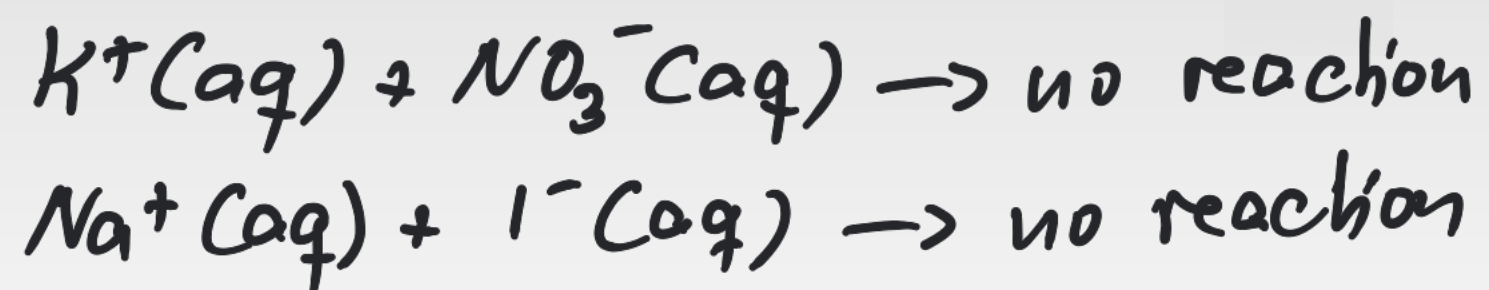
Hard Water :  $\text{Ca}^{2+}(\text{aq})$  and  $\text{Mg}^{2+}(\text{aq})$   
 $\Rightarrow$  add  $\text{Na}_2\text{CO}_3$  to laundry detergent :



## Precipitation Reaction



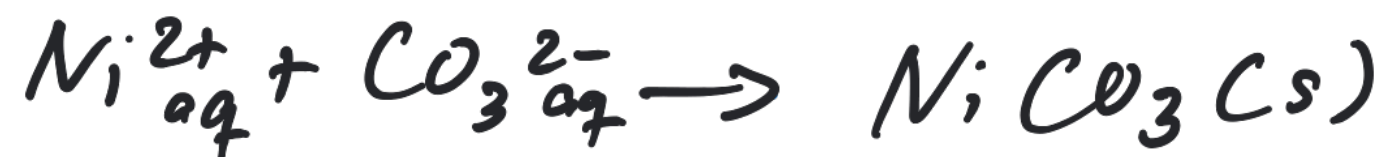
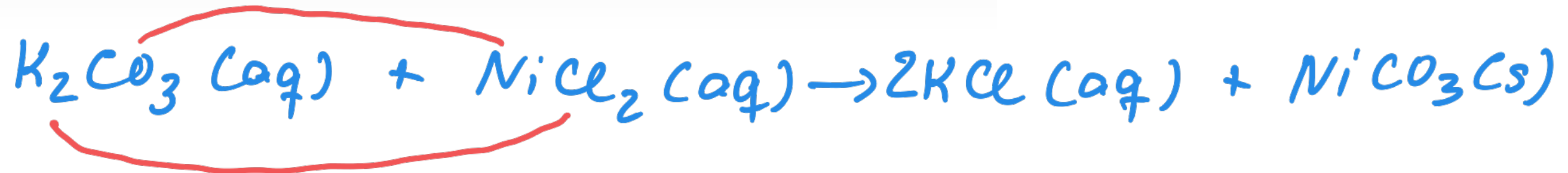
In contrast:



### Examples of Precipitation Reaction

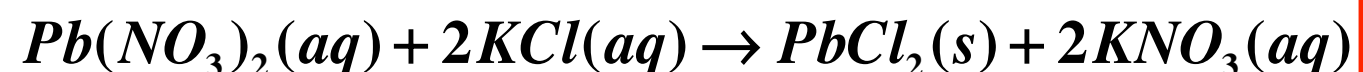
Write an equation for the precipitation reaction that occurs (if any) when solutions of potassium carbonate and nickel(II)chloride are mixed.

1. Write the formulas of the two compounds being mixed as reactants in a chemical equation
2. Below the equation, write the formulas of the products that could form for the reactants (cation + anion). Make sure to write correct formulas.
3. Refer to the solubility rules to determine whether any of the possible products are insoluble
4. If all of the possible products are soluble, there will be no precipitate. Write "No Reaction" after the arrow.
5. If any of the possible products are insoluble, write their formulas as the products of the reaction, using (s) to indicate solid. Write any soluble products with (aq) to indicate aqueous.
6. Balance the equation

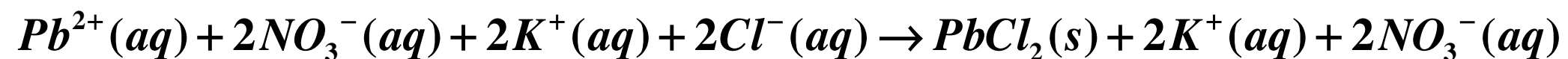


## Molecular, Complete Ionic and Net Ionic Equation

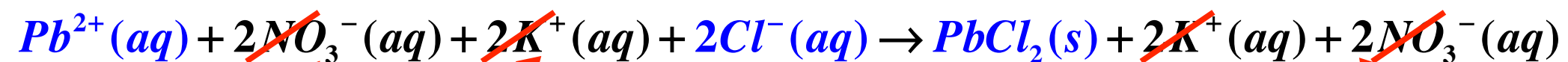
**Molecular Equation:** Chemical equation showing the complete, neutral formulas for every compound in the reaction.



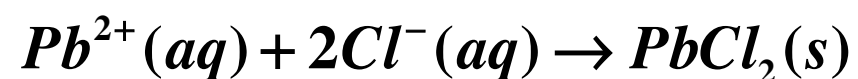
**Complete Ionic Equation:** Chemical equation showing all the species as they are actually present in solution.

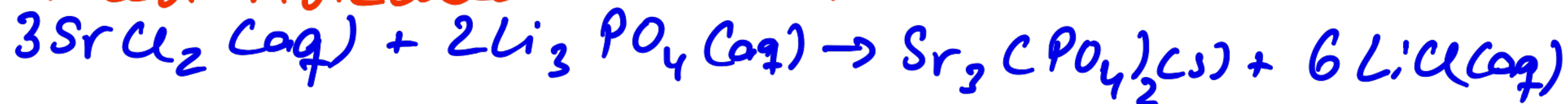


**Net Ionic Equation:** Equation showing only the species that actually change during the reaction.

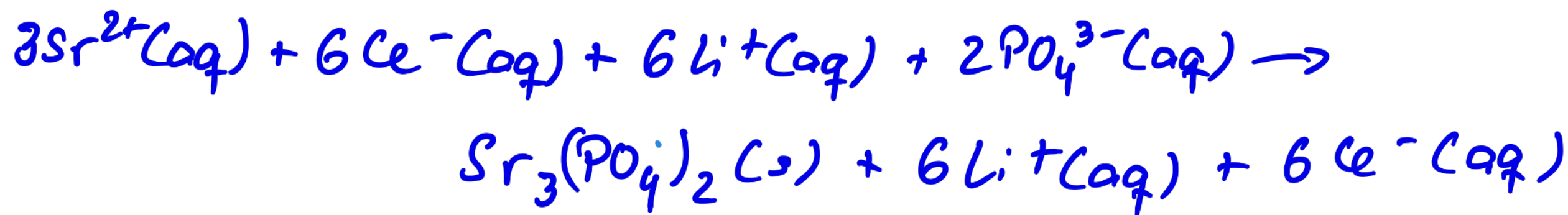


Spectator Ions





Complete Ionic Equation



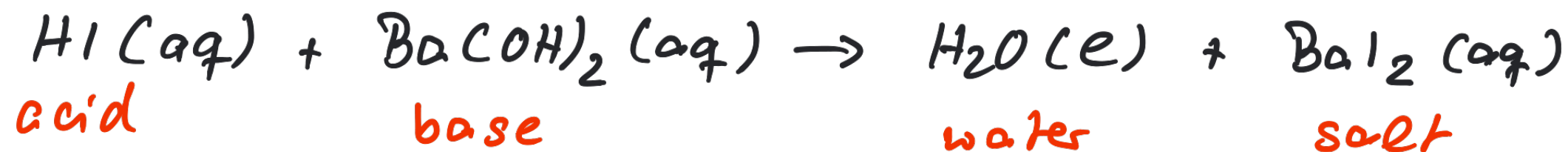
Net ionic equation

Spectator ions:  $\text{Li}^{+}$ ,  $\text{Cl}^{-}$

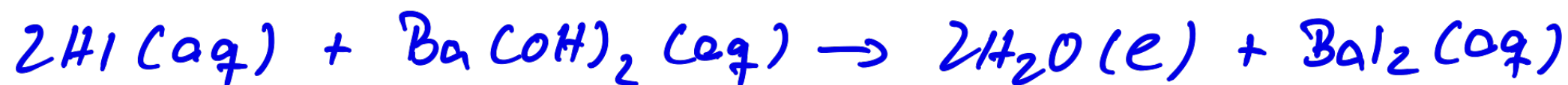


Example 2: Acid / Base reaction

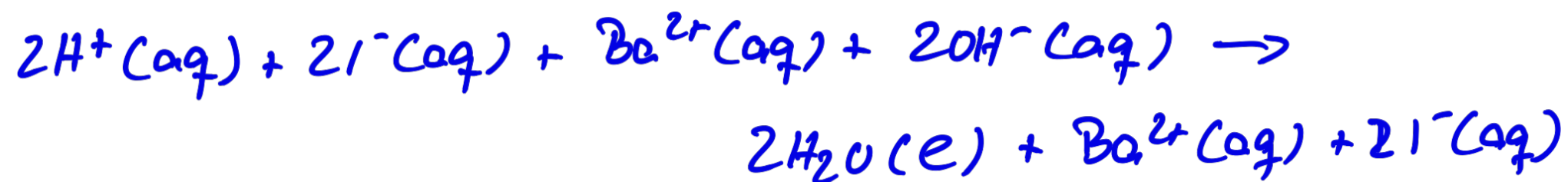
Unbalanced:



Molecular Equation



Complete Ionic



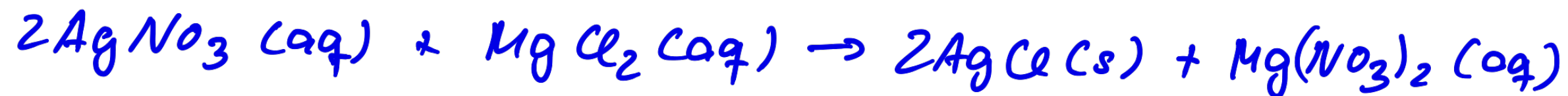
Net Ionic:

Spectator:  $\text{Ba}^{2+}$ ,  $\text{I}^-$

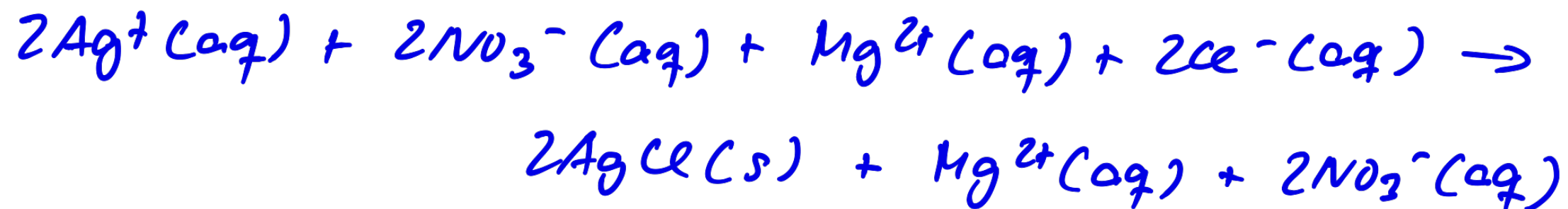




### Example 3



Complete ionic:



Net ionic

