ch. 10.3 solubility rules & double replacement Rx

Solubility rules of ionic compound: based on anion

TABLE 4.1 • Solubility Guidelines for Common Ionic Compounds in Water

Soluble Ionic Compounds		Important Exceptions
Compounds containing	NO_3^-	None
	CH_3COO^-	None
	Cl^-	Compounds of Ag^+, Hg_2^{2+}, and Pb^{2+}
	Br^-	Compounds of Ag^+, Hg_2^{2+}, and Pb^{2+}
	I^-	Compounds of Ag^+, Hg_2^{2+}, and Pb^{2+}
	SO_4^{2-}	Compounds of Sr^{2+}, Ba^{2+}, Hg_2^{2+}, and Pb^{2+}
Insoluble Ionic Compounds		**Important Exceptions**
Compounds containing	S^{2-}	Compounds of NH_4^+, the alkali metal cations, Ca^{2+}, Sr^{2+}, and Ba^{2+}
	CO_3^{2-}	Compounds of NH_4^+ and the alkali metal cations
	PO_4^{3-}	Compounds of NH_4^+ and the alkali metal cations
	OH^-	Compounds of NH_4^+, the alkali metal cations, Ca^{2+}, Sr^{2+}, and Ba^{2+}

source: https://sites.lps.org/sputnam/LHS_IB/IBChemistry/Chemistry_Brown_12th.pdf

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double replacement Rx

- involves ionic compounds as reactants

  AB + CD → AD + CB

- "switch" cations (or anions)

  ex 1. silver + calcium → calcium + silver
  nitrate chloride nitrate chloride
  $AgNO_3$ + $CaCl_2$ → $Ca(NO_3)_2$ + $AgCl$

  ex 2. H_2SO_4 + NaOH → Na_2SO_4 + H_2O (i.e. HOH)

  ex 3. Na_2CO_3 + HCl → H_2CO_3 + NaCl
  but H_2CO_3 is unstable – to form CO_2 & water; see: https://www.youtube.com/watch?v=sHhT9tmePbk
  i.e. it's Na_2CO_3 + HCl → CO_2 + H_2O + NaCl

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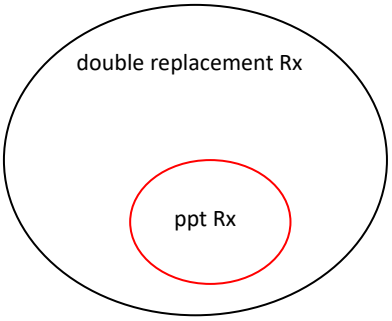
precipitation Rx (ppt Rx)

- forms a precipitate = solid ionic compound; i.e. it's insoluble, where you use the (ionic) solubility rules to identify the precipitate
- it's a double replacement reaction



- example: $AgNO_{3(aq)} + CaCl_{2(aq)} \rightarrow Ca(NO_3)_{2(aq)} + AgCl_{(s)}$

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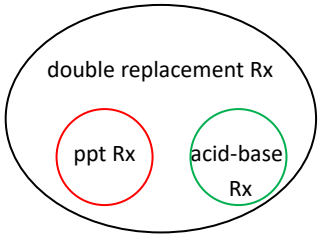
acid – base reaction

- Arrhenius definition (modified)
  - acid = soluble ionic compound, where the cation = H^+
  - base = soluble ionic compound, where the anion = OH^-
- products (usually) water & salt
  - salt = soluble ionic compound, where cation from base & anion from acid
- example:

  $H_2SO_4 + NaOH \rightarrow Na_2SO4 + H_2O$
- it's a double replacement reaction, too



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net ionic equations

- shows only chemicals that "change"; i.e. are "involved" in the reaction

"steps"

1. write the chemical (or molecular) equation to describe the Rx
2. write the complete ionic equation – apply solubility rules
3. write the net ionic equation (by eliminating spectator ions)

ex 1. mix aqueous solutions of silver nitrate and sodium chloride

1. $AgNO_{3(aq)} + NaCl_{(aq)} \rightarrow NaNO_{3(aq)} + AgCl_{(s)}$
2. $Ag^{+}_{(aq)} + \cancel{NO^{-}_{3(aq)}} + \cancel{Na^{+}_{(aq)}} + Cl^{-}_{(aq)} \rightarrow \cancel{Na^{+}_{(aq)}} + \cancel{NO^{-}_{(3)aq)}} + AgCl_{(s)}$
3. $Ag^{+}_{(aq)} + Cl^{-}_{(aq)} \rightarrow AgCl_{(s)}$

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continue – more examples

"steps"

1. write the chemical (or molecular) equation to describe the Rx
2. write the complete ionic equation – apply solubility rules
3. write the net ionic equation (by eliminating spectator ions)

ex 2. mix aqueous solutions of hydrogen sulfate and sodium hydroxide; it's a acid – base Rx

1. $H_2SO_{4(aq)} + NaOH_{(aq)} \rightarrow Na_2SO_{4(aq)} + H_2O_{(l)}$
2. $H^{+}_{(aq)} + \cancel{SO^{-2}_{4(aq)}} + \cancel{Na^{+}_{(aq)}} + OH^{-}_{(aq)} \rightarrow \cancel{Na^{+}_{(aq)}} + \cancel{SO^{-2}_{4(aq)}} + H_2O_{(l)}$
3. $H^{+}_{(aq)} + OH^{-}_{(aq)} \rightarrow H_2O_{(l)}$

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continue – more examples

"steps"

1. write the chemical (or molecular) equation to describe the Rx
2. write the complete ionic equation – apply solubility rules
3. write the net ionic equation (by eliminating spectator ions)

ex 3. mix aqueous solutions of sodium carbonate and hydrogen chloride

1. $Na_2CO_{3(aq)} + HCl_{(aq)} \rightarrow CO_{2(g)} + H_2O_{(l)} + NaCl_{(aq)}$
2. $\cancel{Na^+_{(aq)}} + CO^{-2}_{3(aq)} + H^+_{(aq)} + \cancel{Cl^-_{(aq)}} \rightarrow CO_{2(g)} + H_2O_{(l)} + \cancel{Na^+_{(aq)}} + \cancel{Cl^-_{(aq)}}$
3. $CO^{-2}_{3(aq)} + H^+_{(aq)} \rightarrow CO_{2(g)} + H_2O_{(l)}$

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