Driving Forces for Chemical Reactions

Formation of an insoluble compound (precipitate)

Formation of a gas

Formation of a weak or non-electrolyte

Solubility of Ionic Compounds

TABLE 5.1 ■ Solubility Rules for Ionic Compounds in Water

Compounds Containing the Following Ions Are Generally Soluble	Exceptions
Li^+, Na^+, K^+, and NH_4^+	None
NO_3^- and $C_2H_3O_2^-$	None
Cl^-, Br^-, and I^-	When these ions pair with Ag^+, Hg_2^{2+}, or Pb^{2+}, the resulting compounds are insoluble.
SO_4^{2-}	When SO_4^{2-} pairs with Sr^{2+}, Ba^{2+}, Pb^{2+}, Ag^+, or Ca^{2+}, the resulting compound is insoluble.
Compounds Containing the Following Ions Are Generally Insoluble	**Exceptions**
OH^- and S^{2-}	When these ions pair with Li^+, Na^+, K^+, or NH_4^+, the resulting compounds are soluble. When S^{2-} pairs with Ca^{2+}, Sr^{2+}, or Ba^{2+}, the resulting compound is soluble. When OH^- pairs with Ca^{2+}, Sr^{2+}, or Ba^{2+}, the resulting compound is slightly soluble.
CO_3^{2-} and PO_4^{3-}	When these ions pair with Li^+, Na^+, K^+, or NH_4^+, the resulting compounds are soluble.

Precipitation Reactions

$Pb(NO_3)_2$ (aq) + 2 KI (aq) → $2KNO_{3(aq)} + PbI_{2(s)}$

Predict the products

Write products based on ions exchanging places with each other.

If a reaction takes place, one of the products must be a solid, gas or weak/non-electrolyte.

Representing Aqueous Reactions

$Pb(NO_3)_2$ (aq) + KI (aq) →

Molecular Equation

$Pb(NO_3)_{2(aq)} + 2KI_{(aq)} \rightarrow 2KNO_{3(aq)} + PbI_{2(s)}$

Complete (or Total) Ionic Equation

$Pb^{2+}_{(aq)} + 2NO_3^-{}_{(aq)} + 2K^+_{(aq)} + 2I^-_{(aq)} \rightarrow 2K^+_{(aq)} + 2NO_3^-{}_{(aq)} + PbI_{2(s)}$

Net Ionic Equation

$Pb^{2+}_{(aq)} + 2I^-_{(aq)} \rightarrow PbI_{2(s)}$

Representing Aqueous Reactions

$CuCl_2$ (aq) + NaOH (aq) →

Molecular Equation

$CuCl_{2(aq)} + 2\,NaOH_{(aq)} \longrightarrow 2\,NaCl_{(aq)} + Cu(OH)_{2(s)}$

Complete (or Total) Ionic Equation

$Cu^{2+}_{(aq)} + 2Cl^-_{(aq)} + 2Na^+_{(aq)} + 2OH^-_{(aq)} \longrightarrow 2Na^+_{(aq)} + 2Cl^-_{(aq)} + Cu(OH)_{2(s)}$

Net Ionic Equation

$Cu^{2+}_{(aq)} + 2OH^-_{(aq)} \longrightarrow Cu(OH)_{2(s)}$

Representing Aqueous Reactions

NaBr (aq) + RbCl (aq) →

Molecular Equation

$NaBr_{(aq)} + RbCl_{(aq)} \rightarrow NaCl_{(aq)} + RbBr_{(aq)}$

Complete (or Total) Ionic Equation

$Na^+_{(aq)} + Br^-_{(aq)} + Rb^+_{(aq)} + Cl^-_{(aq)} \rightarrow Na^+_{(aq)} + Cl^-_{(aq)} + Rb^+_{(aq)} + Br^-_{(aq)}$

Net Ionic Equation

None

Representing Aqueous Reactions

*HNO_3 (aq) + NaOH (aq) →

Molecular Equation

$HNO_{3(aq)} + NaOH_{(aq)} \rightarrow NaNO_{3(aq)} + H_2O_{(l)}$

Complete (or Total) Ionic Equation

$H^+_{(aq)} + NO_3^-{}_{(aq)} + Na^+_{(aq)} + OH^-_{(aq)} \rightarrow Na^+_{(aq)} + NO_3^-{}_{(aq)} + H_2O_{(l)}$

Net Ionic Equation

$H^+_{(aq)} + OH^-_{(aq)} \rightarrow H_2O_{(l)}$

*HNO_3 ionizes completely in water