



Chemical Reactions and Equations

Chapter 8

Describing Chemical Reactions

- A chemical reaction is the process by which one or more substances are changed into different substances

Reactants → Products

When methane burns in air, it combines with oxygen to produce carbon dioxide and water.

- Chemical equations represent, with symbols and formulas, the identities and relative amounts of the reactants and products in a chemical reaction



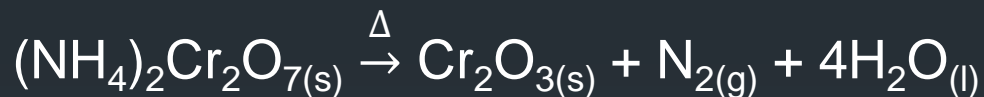
Describing Chemical Reactions

- To know for certain that a chemical reaction has taken place requires chemical analysis for proof that one or more substances has undergone a change in identity
- However, certain easily observed changes usually indicate that a chemical reaction has occurred
 1. Evolution of heat and light
 2. Production of a gas
 3. Formation of a precipitate
 4. Color change

Describing Chemical Reactions

Word equations to chemical equations

Solid ammonium dichromate decomposes when heated to yield solid chromium (III) oxide and gaseous nitrogen and water.



- The equation must represent known facts
- The equation must contain the correct formulas for the reactants and products
- The law of conservation of mass must be satisfied

Balancing Chemical Reactions

For each of the following, generate a chemical equation.

- Solid magnesium and aqueous hydrochloric acid react to form aqueous magnesium chloride and hydrogen gas.



- Aqueous nitric acid reacts with solid calcium hydroxide to produce aqueous calcium nitrate and water.



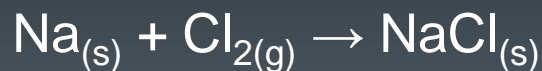
Balancing Chemical Reactions

For each of the following, generate a chemical equation.

- Solid aluminum carbide reacts with water to produce methane gas and solid aluminum hydroxide.



- Solid sodium combines with chlorine gas to produce solid sodium chloride.



Balancing Chemical Reactions

For each of the following, generate a chemical equation.

- When solid copper reacts with aqueous silver nitrate, the products are copper (II) nitrate and solid silver.



- In a blast furnace, the reaction between solid iron (III) oxide and carbon monoxide gas produces solid iron and carbon dioxide gas.



Balancing Chemical Reactions

For each of the following, generate a chemical equation.

- When liquid hexane (C_6H_{14}) is burned in the presence of oxygen gas, carbon dioxide and water vapor are produced.



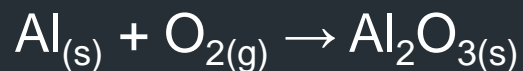
- Liquid carbon tetrachloride is produced from the reaction of methane (CH_4) with chlorine gas. Hydrogen chloride is a by-product



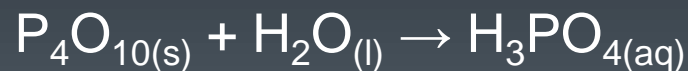
Balancing Chemical Reactions

For each of the following, generate a chemical equation.

- Aluminum reacts with oxygen to produce solid aluminum oxide.



- Phosphoric acid is produced through the reaction of tetraphosphorous decoxide and water.



Balancing Chemical Reactions

For each of the following, generate a chemical equation.

- Solid potassium chlorate is heated to produce solid potassium chloride and oxygen gas.



Balancing Chemical Reactions

Most equations can be balanced by inspection but there are a few helpful hints that will make it easier.

- Balance the atoms one at a time
- Balance polyatomic ions that appear on both sides as single units
- Balance atoms that appear alone last
- Check to make sure your final coefficients are in the lowest whole number ratio possible

Balancing Chemical Reactions

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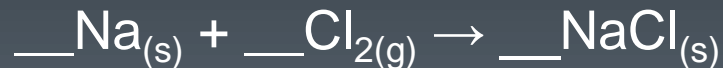
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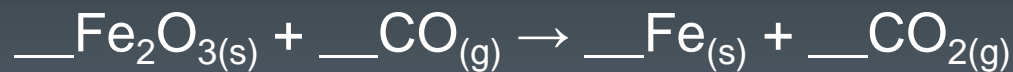
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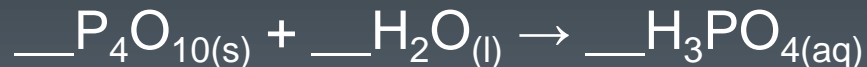
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Types of Chemical Reactions



There are several different ways to categorize chemical reactions and none are entirely satisfactory. The classification system described in this chapter is an intro to the five basic types of reactions:

1. Synthesis
2. Decomposition
3. Combustion
4. Single Replacement
5. Double Replacement

Types of Chemical Reactions

Synthesis

- Two or more substances combine to form a new compound
- $A + X \rightarrow AX$
- $2\text{Mg}_{(s)} + \text{O}_{2(g)} \rightarrow 2\text{MgO}_{(s)}$

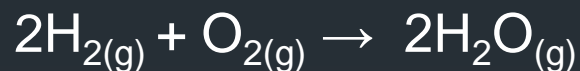
Decomposition

- A single compound undergoes a reaction that produces two or more simpler substances
- $AX \rightarrow A + X$
- $2\text{H}_2\text{O}_{(l)} \rightarrow 2\text{H}_{2(g)} + \text{O}_{2(g)}$

Types of Chemical Reactions

Combustion

- A substance (usually a hydrocarbon) combines with oxygen to release a large amount of energy in the form of heat and light



Water as a Medium for Reactions

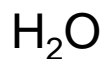
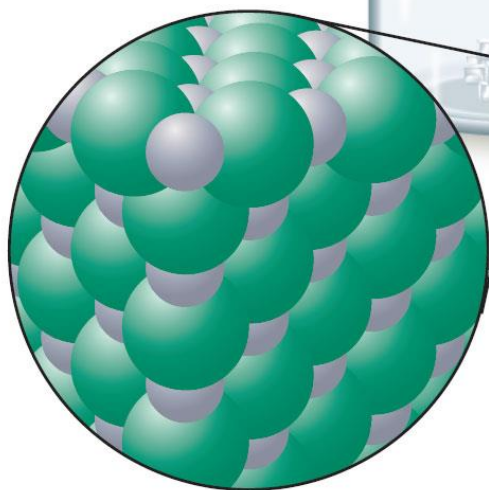


- Many chemical reactions take place in an aqueous environment
- Water provides a medium in which reacting species can move around and collide with each other

Water as a Medium for Reactions

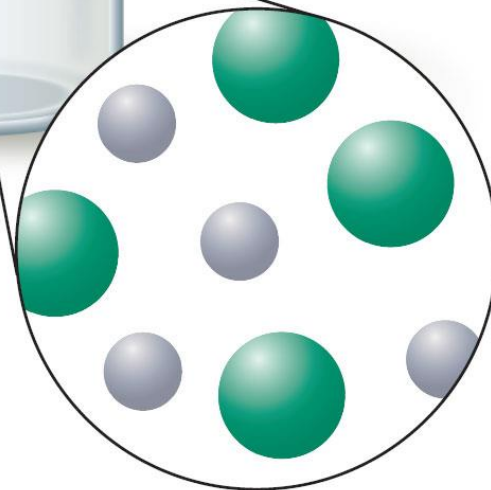
Solid Phase

- Ions are rigidly held in place
- No freedom of movement

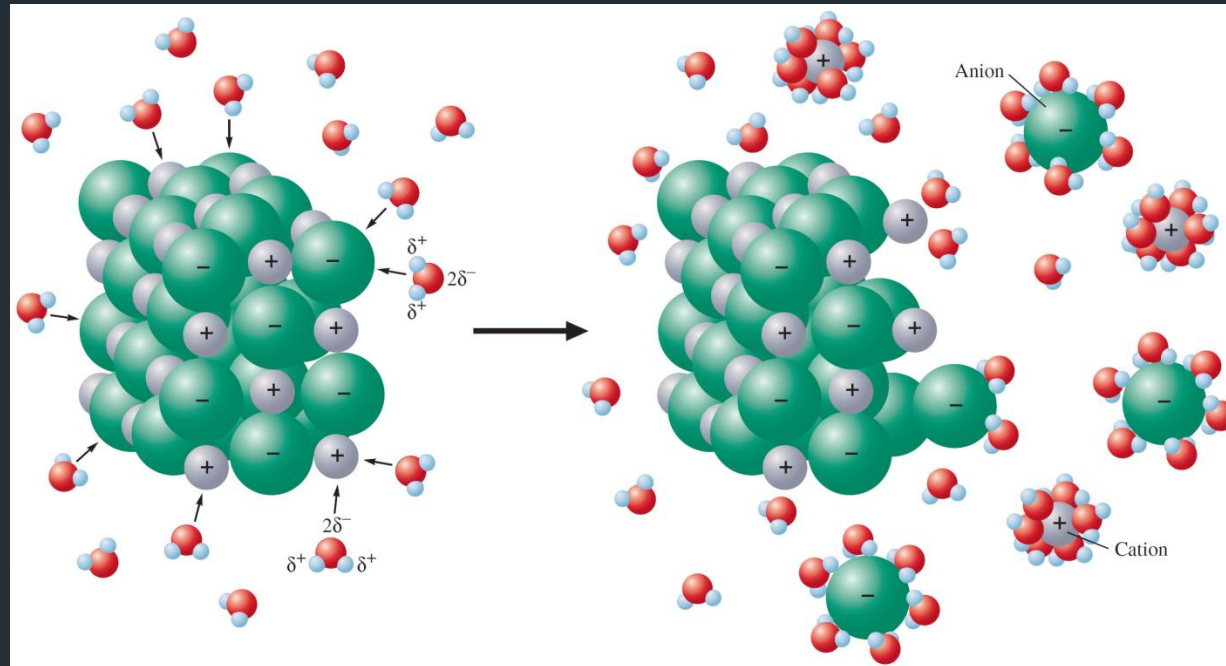


Aqueous Phase

- Ions are unbound
- Free to move independently

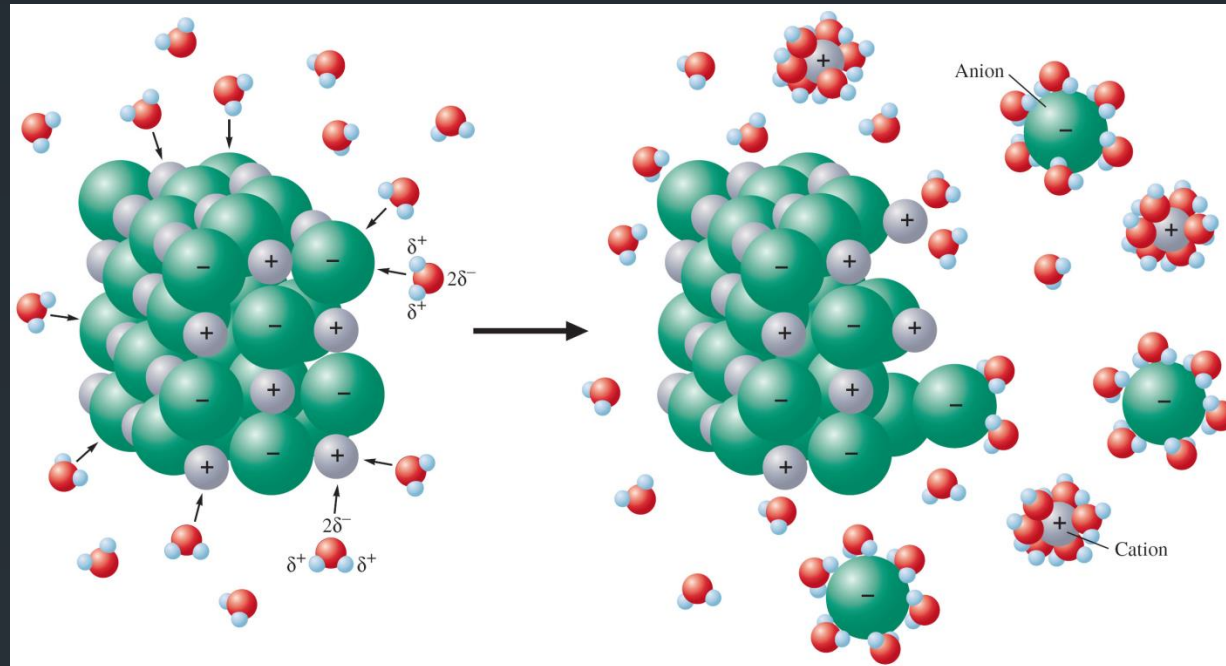


The Dissolution Process



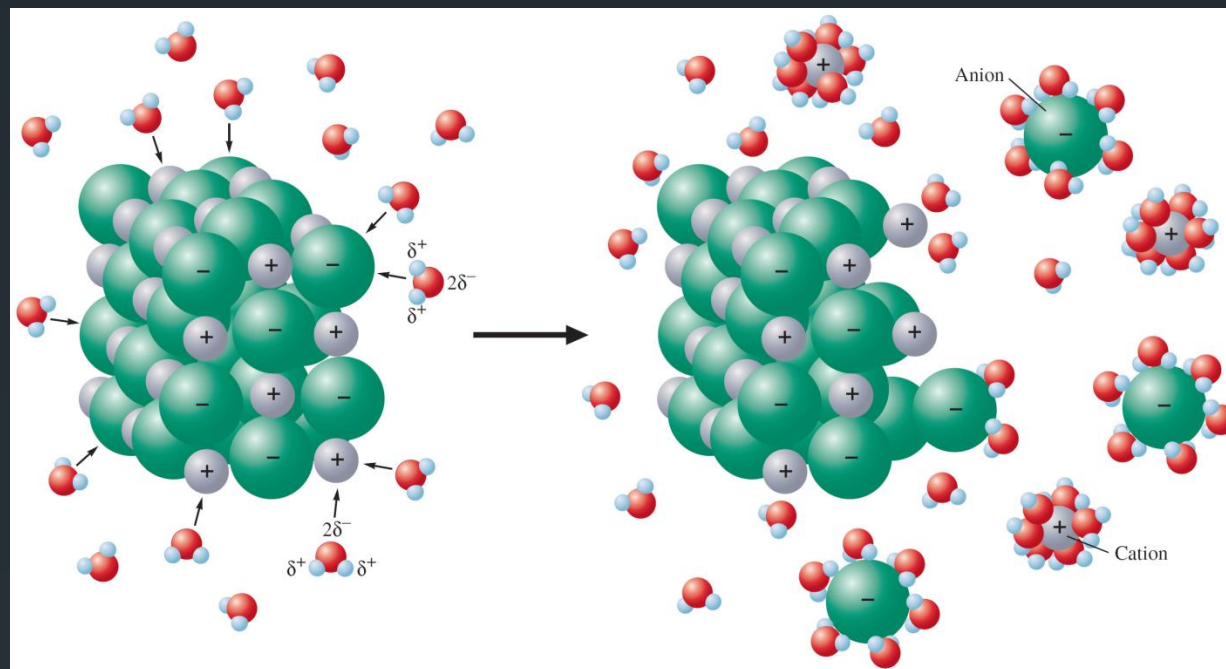
- Ionic compounds break up into their respective ions in solution

The Dissolution Process



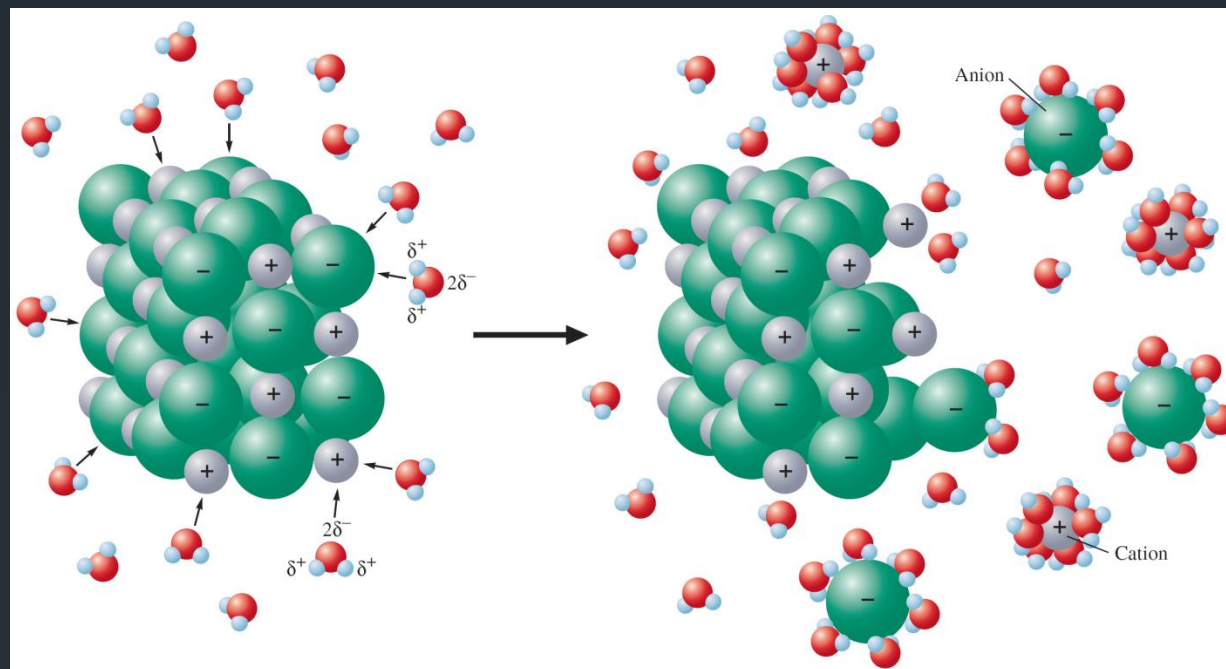
- The name of the compound is a direct indicator of the ions that make it up

The Dissolution Process



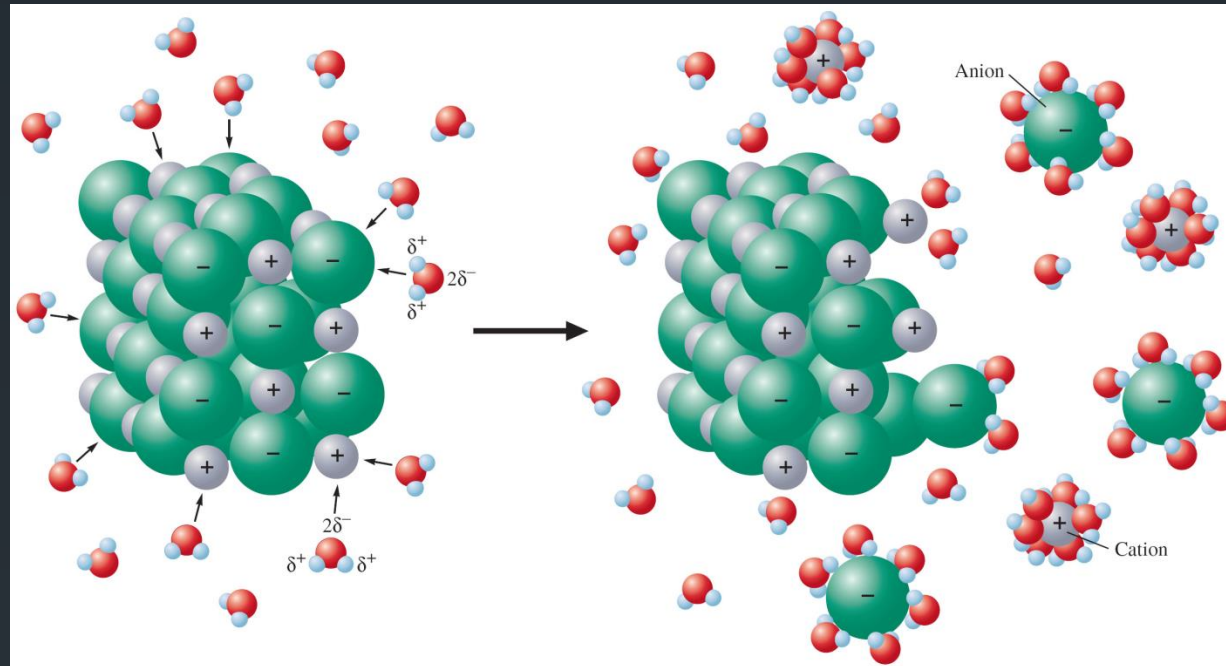
- For example NaCl is named sodium chloride
- $\text{NaCl}_{(s)} \xrightarrow{\text{H}_2\text{O}} \text{NaCl}_{(aq)} \text{ or } \text{Na}^+_{(aq)} + \text{Cl}^-_{(aq)}$

The Dissolution Process



- CaBr_2 is named calcium bromide
- $\text{CaBr}_{2(s)} \xrightarrow{\text{H}_2\text{O}} \text{CaBr}_{2(aq)} \text{ or } \text{Ca}^{2+}_{(aq)} + 2\text{Br}^{-}_{(aq)}$

The Dissolution Process



- Na_2CO_3 is called sodium carbonate
- $\text{Na}_2\text{CO}_{3(s)} \xrightarrow{\text{H}_2\text{O}} \text{Na}_2\text{CO}_{3(aq)} \text{ or } 2\text{Na}^+_{(aq)} + \text{CO}_3^{2-}_{(aq)}$

Single Replacement Reactions

- One element replaces another less active element in a compound
- $\text{Mg}_{(s)} + \text{H}_2\text{O}_{(l)}$
- Mg is more active than H so Mg replaces one of the Hs in the compound
- $\text{Mg}_{(s)} + \text{H}_2\text{O}_{(l)} \rightarrow \text{Mg}(\text{OH})_{2(aq)} + \text{H}_{2(g)}$



Single Replacement Reactions

- One element replaces another less active element in a compound
- $\text{Au}_{(s)} + \text{H}_2\text{O}_{(l)}$
- Au is less active than H so no replacement occurs
- $\text{Au}_{(s)} + \text{H}_2\text{O}_{(l)} \rightarrow \text{no reaction}$



Single Replacement Reactions

Use Table J to predict whether or not a reaction will occur.

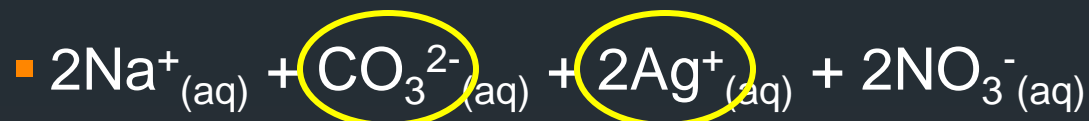
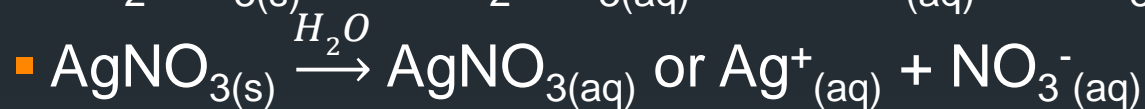
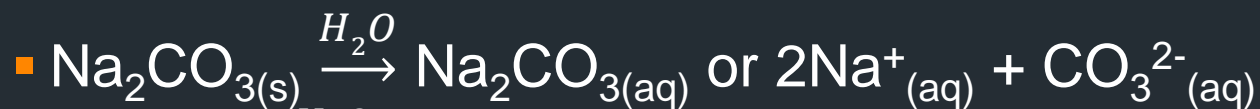


Double Replacement Reactions

- When solutions are mixed the ions have a chance to interact with other
- $\text{CaBr}_{2(aq)} + \text{NaCl}_{(aq)}$
- $\text{Ca}^{2+}_{(aq)} + 2\text{Br}^{-}_{(aq)} + \text{Na}^{+}_{(aq)} + \text{Cl}^{-}_{(aq)} \rightarrow \text{no reaction}$



Double Replacement Reactions



PRECIPITATE

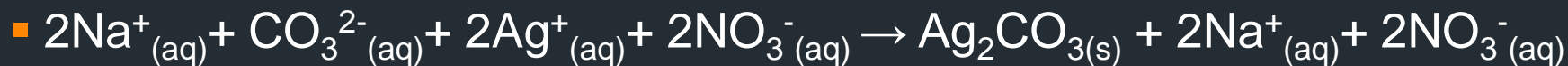
Na⁺
Na⁺
CO₃²⁻

Ag⁺
NO₃⁻

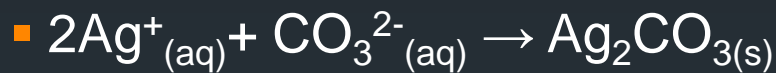
Solutions are mixed

Na⁺
NO₃⁻
Ag₂CO₃

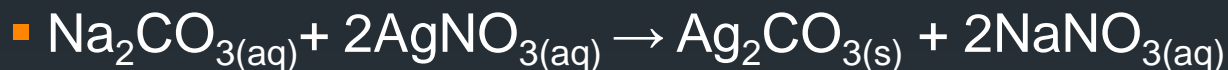
Double Replacement Reactions



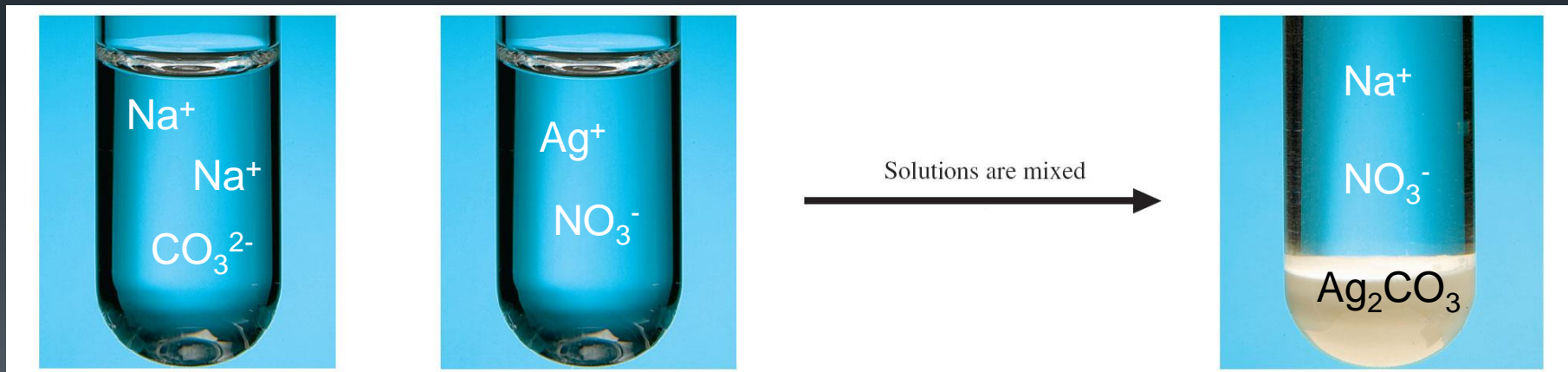
Complete Ionic



Net Ionic – eliminates spectator ions



Molecular



Double Replacement Reactions

Using the solubility guidelines, predict whether or not the following double replacement reactions will occur. For those reactions that will proceed, write the products and balance the resulting chemical equation.



Double Replacement Reactions

Look for evidence of a chemical reaction when combining 2 different salt solutions

- KOH
- KI
- $\text{Pb}(\text{NO}_3)_2$
- BaCl_2
- K_2SO_4
- Na_3PO_4
- AgNO_3

Double Replacement Reaction

	KOH	KI	Pb(NO ₃) ₂	BaCl ₂	K ₂ SO ₄	Na ₃ PO ₄	AgNO ₃
KOH							
KI							
Pb(NO ₃) ₂							
BaCl ₂							
K ₂ SO ₄							
Na ₃ PO ₄							
AgNO ₃							