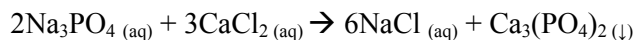


## Chemical Reactions 7

# Ionic Equations

### INFORMATION

Consider the following double replacement chemical equation:

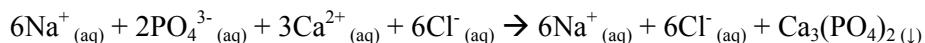


This equation is called a **molecular equation**. Molecular equations are the most common form of chemical equation found in chemistry; they indicate the formulas and states of the products and the reactants, but give no indication as to the ionic structure of the compounds.

**Ionic equations** are used to designate the ionic structure of the chemical species involved in a reaction. It shows which of the reactants or products exists primarily as ions in solution.

### Complete Ionic Equations

A **complete ionic equation** describes the chemical reaction while simultaneously demonstrating which of the reactants and products exist primarily as ions in an aqueous solution. Consider the complete ionic equation for the reaction above:



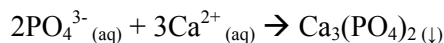
Notice that all moles of all of the ions present in the molecular equation are represented in the complete ionic equation. This is done by converting all subscripts to appropriate coefficients. For example, the compound  $\text{CaCl}_2$  has a coefficient of 3 in the molecular equation. There a total of 6 chloride ions ( $\text{Cl}^-$ ); 2 in each mole of calcium chloride, and 3 total moles  $- 2 \times 3 = 6$  ions.

Notice also that  $\text{Ca}_3(\text{PO}_4)_2(\text{s})$  is insoluble; it manifests as a precipitate. For this reason, it is shown as a complete compound and not as dissociated ions.

### Net Ionic Equations

A **net ionic equation** is one that shows only the ions and species that participate in the reaction. Ions that do not participate in the reaction (that is, those that simply stay in solution without reacting) are known as **spectator ions**.

As you can see in the complete ionic equation above,  $6\text{Na}^+(\text{aq})$  and  $6\text{Cl}^-(\text{aq})$  appear on both sides of the reaction. Just like in an algebraic equation, terms that appear on both sides of the equation can be cancelled out. After canceling these ions from both sides, the net ionic equation appears as:



### Critical Thinking Questions

For each of the equations given below, write the molecular equation, the complete ionic equation, and the net ionic equation. Be sure to make sure each equation is properly balanced.

1. sodium hydroxide is neutralized by sulfuric acid
2. plumbous sulfate and silver nitrate react
3. potassium acetate and zinc chloride react in solution
4. calcium hydroxide and phosphoric acid neutralize each other
5. the reaction of aluminum bromide with magnesium hydroxide