Unit 2 – Aqueous Reactions

Lesson 2: Net Ionic Equations

Guiding Questions

- How do we write balanced equations for double displacement and net-ionic precipitation reactions?
- What is a precipitation equation?
- What is a molecular equation?
- What is a net ionic equation?

A precipitation reaction is a chemical reaction between ions in solution that results in the formation of a precipitate.

From yesterday:

$$AgNO_3(aq) + NaCl(aq) \rightarrow AgCl(s) + NaNO_3(aq)$$

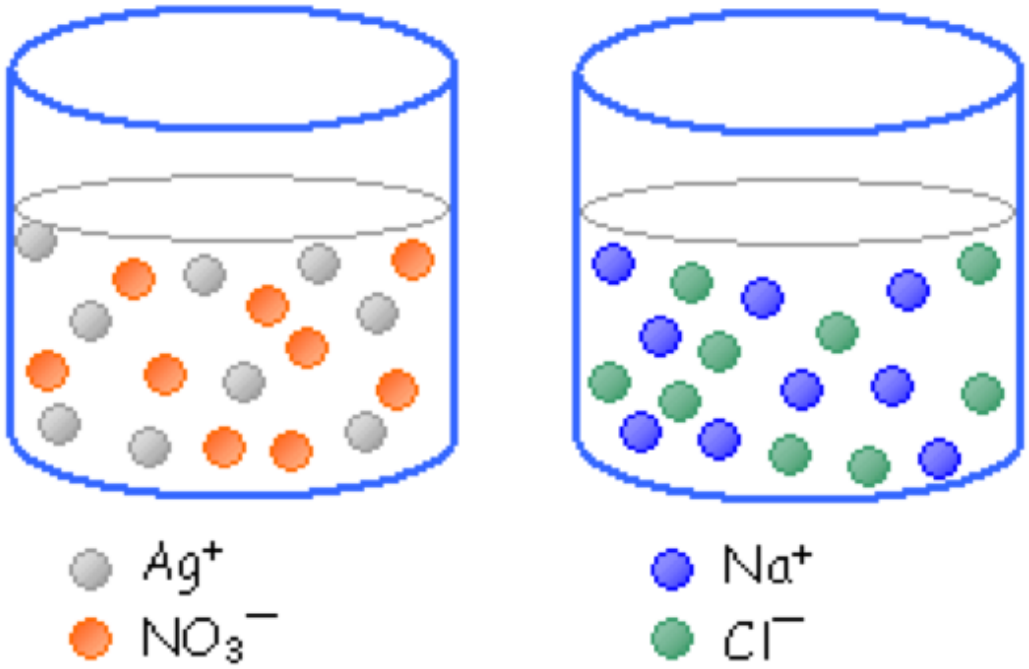
All precipitation reactions are double replacement reactions. The equation above is called the **precipitation equation** or **molecular equation** because it shows the ions together as if they formed neutral molecules.

Review:

A **double displacement** reaction is a reaction in which two compounds react by an exchange of ions to form two new compounds. A double displacement reaction usually occurs in solution and one of the products, being insoluble precipitates out.

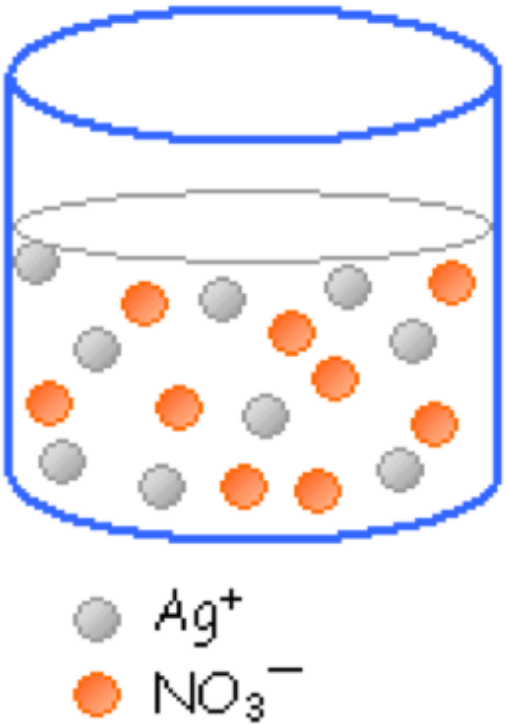
The molecular equation is not an accurate representation of what is actually occurring. It does give us an indication of the contents of each solution, but we know that the ions are not together in the solutions.

A more accurate representation is the ionic equation. The ionic equation shows all ions in their dissociated form.



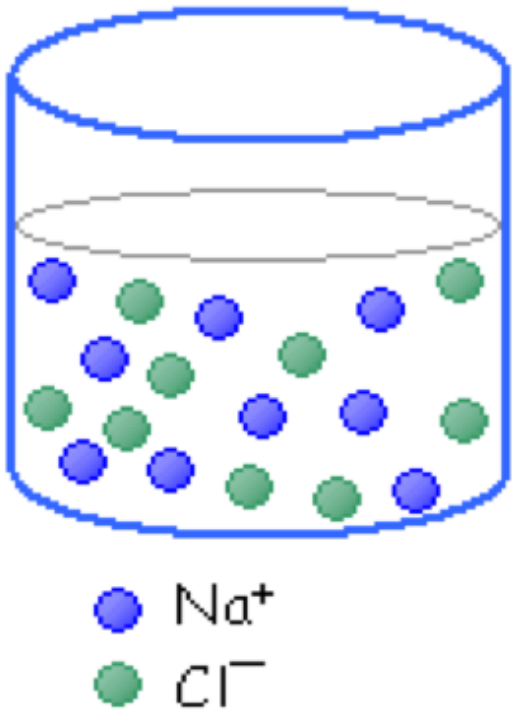
The equation for the dissociation of silver nitrate in water is

$AgNO_3(aq) \rightarrow Ag^+(aq) + NO_3^-(aq)$



The equation for the dissociation of sodium chloride in water is

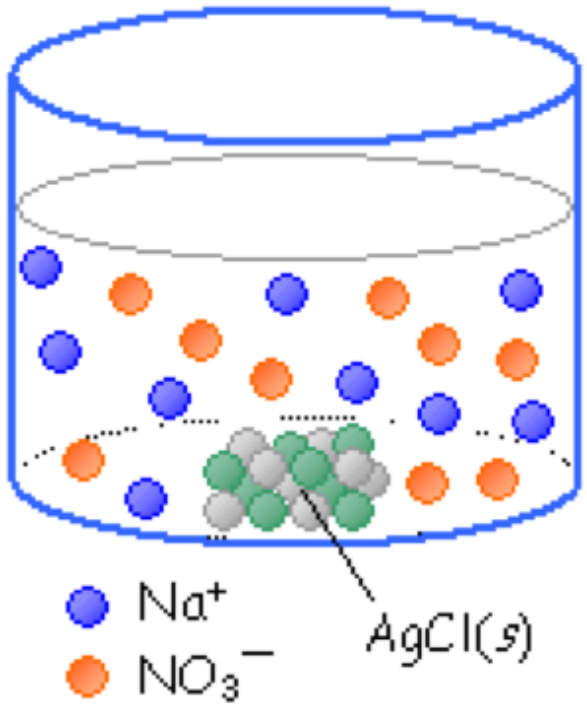
$NaCl(aq) \rightarrow Na^+(aq) + Cl^-(aq)$



These two dissociation equations reflect the ions present before the two solutions are mixed. The ions are the reactants in the reaction.

The ionic equation for the reaction between aqueous silver nitrate and aqueous sodium chloride is:

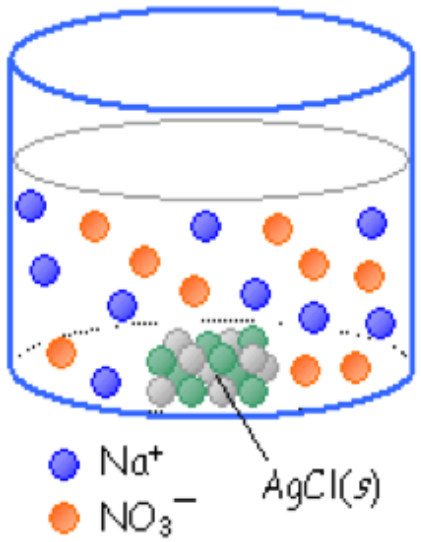
$Ag^+(aq) + NO_3^-(aq) + Na^+(aq) + Cl^-(aq) \rightarrow AgCl(s) + Na^+(aq) + NO_3^-(aq)$



The ionic equation for the reaction between aqueous silver nitrate and aqueous sodium chloride is:

$Ag^+(aq) + NO_3^-(aq) + Na^+(aq) + Cl^-(aq) \rightarrow AgCl(s) + Na^+(aq) + NO_3^-(aq)$

Notice we have not separated the silver chloride into ions since after the reaction is complete because the silver and chloride ions are not able to move freely. The ions are held into a solid ionic compound. The ionic equation also includes the spectator ions, whereas the net ionic equation shows the actual reaction that occurs, without the spectator ions.



We do not include the spectator ions in the net ionic equation because they do not participate in the reaction. They remain unchanged throughout the reaction. By eliminating the spectators from the ionic equation we get

The net ionic equation for the reaction between aqueous silver nitrate and aqueous sodium chloride is:

$$Ag^+(aq) + NO_3^-(aq) + Na^+(aq) + Cl^-(aq) \rightarrow AgCl(s) + Na^+(aq) + NO_3^-(aq)$$

$$Ag^+(aq) + Cl^- (aq) \rightarrow AgCl(s)$$

Example 2

Write the complete set of equations (molecular, ionic and net ionic) for the reaction between aqueous lead (II) nitrate and aqueous potassium iodide.

Step 1: Identify the ions present:

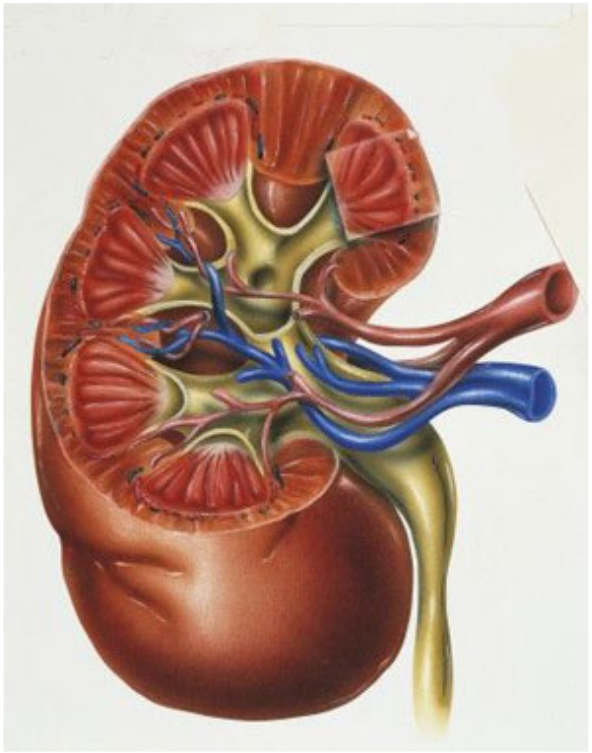
Step 2: Write the formulas of the 2 possible compounds formed from the ions.

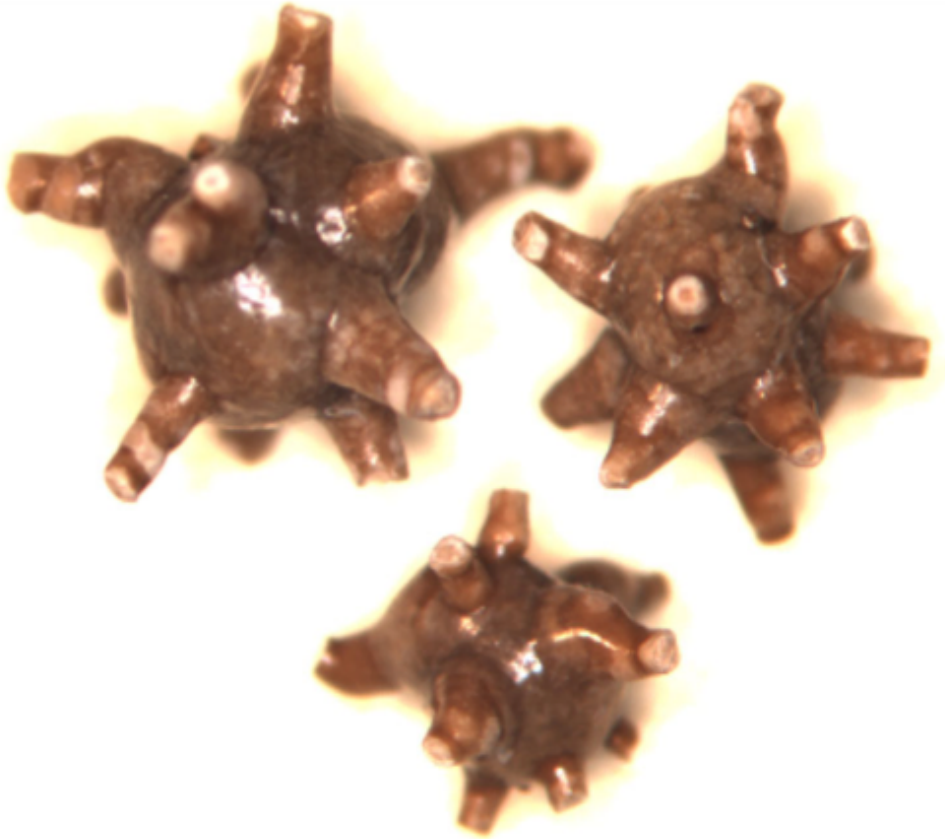
Step 3: Determine which, if any, of these compounds would form a precipitate.

Common Precipitation Reactions

Hot water pipes and kettles can get clogged because precipitates form with magnesium and calcium ions in “hard” water combine with carbonates and oxides in the water. As these precipitates form, they deposit in the pipes and kettles.

Kidney stones form when calcium ions, usually from dairy products, and oxalates or phosphates form precipitates in the kidney and urinary tract. These precipitates can form large crystals and block the urinary tract. One way to avoid kidney stones is to drink a lot of water. The added water increases the amount of these precipitates that can dissolve.





Limestone formations in caves are due to the precipitation of calcium carbonate carried by water draining into the cave.

Guiding Questions

- How do we write balanced equations for double displacement and net-ionic precipitation reactions?
- What is a precipitation equation?
- What is a molecular equation?
- What is a net ionic equation?