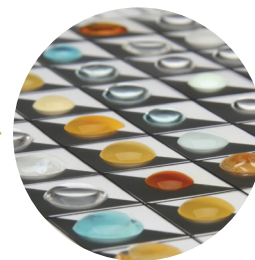


# A Visual Introduction to Ionic and Net Ionic Equations

## A Carolina Essentials™ Activity

### Student Worksheet



#### Overview

Formation of a precipitate, formation of a gas, and a change in color are phenomena indicating that a chemical reaction has occurred. When ionic compounds dissolve in water to form a solution during the process known as dissociation, the anion (negatively charged ion) and cation (positively charged ion) separate. When table salt, or sodium chloride ( $\text{NaCl}$ ), dissolves in water, the sodium cations ( $\text{Na}^+$ ) and chloride anions ( $\text{Cl}^-$ ) dissociate. When two or more solutions of different ionic compounds are mixed, their ions may react. If a reaction product has low solubility, a precipitate forms. Unreactive ions, called spectator ions, remain in solution.

Some compounds are more soluble in water than others. The solubility of a compound is described as the mass of that compound that will dissolve in 100 grams of water at  $20^\circ\text{C}$ . Through experimentation, a table of general solubility rules has been established to help predict the composition of low solubility products.

To model the process of dissociation and precipitate formation, chemists use a two-step technique and write ionic and net ionic equations. The ionic equation shows all the ions produced through dissociation and the formation of the low solubility precipitate. The net ionic equation models just the formation of the precipitate from its ions and removes the spectator ions

#### Essential Question

How is the phenomenon of precipitate formation explained on the atomic level?

#### Activity Objectives

1. Identify reactions that produce precipitates.
2. Model the formation of a precipitate using ionic and net ionic equations.

#### SAFETY REQUIREMENTS



#### MATERIALS

**Dropper bottles of 0.1 M solutions of:**

Sodium phosphate,  $\text{Na}_3\text{PO}_4$   
Copper(II) sulfate,  $\text{CuSO}_4$   
Potassium iodide,  $\text{KI}$   
Lead(II) nitrate,  $\text{Pb}(\text{NO}_3)_2$   
Sodium carbonate,  $\text{Na}_2\text{CO}_3$   
Silver nitrate,  $\text{AgNO}_3$   
Calcium chloride,  $\text{CaCl}_2$   
Sodium hydroxide,  $\text{NaOH}$   
Reaction mat or spot plate  
Absorbent paper towel

Ion	General Solubility Rule
$\text{NO}_3^-$	All nitrates are soluble.
$\text{Cl}^-$ , $\text{Br}^-$ , $\text{I}^-$	All chlorides, bromides, and iodides are soluble, except for $\text{Ag}^+$ and $\text{Pb}^+$ .
$\text{SO}_4^{2-}$	All sulfates are soluble except those of $\text{Ba}^{2+}$ , $\text{Pb}^{2+}$ , $\text{Ca}^{2+}$ , $\text{Sr}^{2+}$ .
$\text{CO}_3^{2-}$ and $\text{PO}_4^{3-}$	All carbonates and phosphates are insoluble, except those of $\text{Na}^+$ , $\text{K}^+$ , and $\text{NH}_4^+$ . Many acid phosphates are soluble.
$\text{OH}^-$	All hydroxides are insoluble except those of $\text{Na}^+$ and $\text{K}^+$ . Hydroxides of $\text{Ba}^{2+}$ and $\text{Ca}^{2+}$ are slightly soluble.
$\text{S}^{2-}$	All sulfides are insoluble except those of $\text{Na}^+$ , and $\text{K}^+$ , and $\text{NH}_4^+$ and those of the alkaline earths: $\text{Mg}^{2+}$ , $\text{Sr}^{2+}$ , $\text{Ba}^{2+}$ and $\text{Ca}^{2+}$ .
$\text{Na}^+$ , $\text{K}^+$ , and $\text{NH}_4^+$	All salts of $\text{Na}^+$ , $\text{K}^+$ and $\text{NH}_4^+$ are soluble.

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## Activity Procedures

1. At the central materials station, get a dropper bottle of each of the 8 chemicals listed in the materials list.
2. If using a reaction mat transparency, place it on top of equations grid, so that the boxes line up. If using spot plates, position the spot plates to align with an ordered list of reactants.
3. Place one drop of sodium phosphate in the reaction square or well in the top left corner of the grid or spot plate. Then add one drop of copper(II) sulfate to that reaction square or well. Do not let the dropper bottle tip touch the drop of the chemical you have already placed in the block or in the well.
4. Record observations.
5. Add the remaining chemicals as listed, one at a time, to the columns and rows of reaction squares.
6. Record observations after each reaction.
7. If chemicals are placed in the wrong reaction square or well, use a rolled-up piece of absorbent paper towel to remove the chemical.

## Disposal

After reacting all the chemical pairs on the grid and recording the data, lay a piece of absorbent paper towel flat across the entire reaction mat or spot plate, and allow it to absorb the chemicals. Discard the paper towel. Use an additional paper towel dampened with distilled or deionized water to clean the reaction mat or spot plate.



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## Data

### Reaction Grid

	$\text{CuSO}_4$	$\text{KI}$	$\text{Pb}(\text{NO}_3)_2$	$\text{Na}_2\text{CO}_3$	$\text{AgNO}_3$	$\text{CaCl}_2$	$\text{NaOH}$
$\text{Na}_3\text{PO}_4$							
$\text{NaOH}$							
$\text{CaCl}_2$							
$\text{AgNO}_3$							
$\text{Na}_2\text{CO}_3$							
$\text{Pb}(\text{NO}_3)_2$							
$\text{KI}$							

X = no visible reaction

ppt = precipitate

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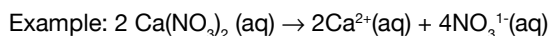
## Analysis and Discussion

1. Identify all reactions that produced a precipitate and write a balanced chemical reaction to model the bonds being broken and reformed at the atomic level and the conservation of matter.

2. What evidence do you have that all the reactants are soluble?

3. Using the chart of solubility rules above, identify the product that is the precipitate and place a (ppt) or (s) to the right of the product formula. Place an (aq) to the right of all chemicals that are soluble.

4. Convert the balanced chemical equation to an ionic equation to model the process of dissociation. Split all soluble chemicals into a cation and anion. Show the charge on the ion. If needed, change the coefficient to reflect the total number of ions in solution.



5. With a single line, mark out the spectator ions with the coefficients. Write the net ionic equation modeling the formation of the precipitate on the atomic level. Make certain it is balanced to illustrate conservation of matter.

6. Use an ionic and net ionic equation to explain why equations are not written for reactions in this activity that do not produce precipitates