Net Ionic Equations
Making Sense of Chemical Reactions

Now that you have mastered writing balanced chemical equations it is time to take a deeper look at what is really taking place chemically in each reaction. There are many driving forces for chemical reactions. By writing the net ionic equation for a reaction it is often evident which driving force caused the reaction. The most common driving forces for chemical reactions are: formation of a precipitate, formation of a molecular compound such as water, and formation of a gas.

PURPOSE
In this activity you will write balanced chemical formulas, total ionic equations and net ionic equations to explain chemical reactions.

MATERIALS
note sheet
solubility rules
periodic table

CLASS NOTES
Net ionic equations represent only the species that are taking part in a chemical reaction. The parts of the equation that are not shown are known as the *spectator ions*. Spectator ions do just that—they "spectate"—they must be present in order for the reaction to occur since compounds are neutral, but they are not directly involved in the reaction. The type of equations that you have become familiar with are known as *balanced formula reactions*. In balanced formula equations all species are shown written as formulas with proper coefficients to balance the atoms. In a *total ionic equation,* substances that ionize extensively in solution are written as ions while all others are written as formulas.

How do you know when a substance will extensively ionize in solution? All strong electrolytes will ionize extensively in solution. Electrolytes are comprised of three classes of compounds—strong acids, strong bases and soluble salts. Using the information that follows you should be able to determine whether or not to ionize a particular substance.

1. **Strong Acids**: HCl, HBr, HI, H_2SO_4, HNO_3, $HClO_4$, $HClO_3$

2. **Strong Bases**: Hydroxides of group IA and IIA (Ba, Sr, Ca are marginal—the ions that do dissolve are in solution 100% and so are ionized when they are in dilute solutions. Be and Mg are weak and are not ionized.)

3. **Soluble Salts** (see Table 1): (ionic compounds: metal/nonmetal)

Table 1

Always Soluble if in a Compound	Except With
NO_3^-, Group IA, NH_4^+, $C_2H_3O_2^-$, ClO_4^-, ClO_3^-	No Exceptions
Cl^-, Br^-, I^-	Pb, Ag, Hg_2^{2+}
SO_4^{2-}	Pb, Ag, Hg_2^{2+} Ca, Sr, Ba

If the substance does not fit into one of the three rules listed in Table 1, assume that it is insoluble or it is a weak electrolyte and does not ionize in solution. (This won't always be correct, but will cover most of the situations you encounter.)

A few other important points:

- Gases, pure liquids, and solids are non-electrolytes.
- H_2CO_3 decomposes into $H_2O_{(l)}$ and $CO_{2(g)}$
- NH_4OH decomposes into $H_2O_{(l)}$ and $NH_{3(g)}$

Let's explore these terms using an example:

- Consider a reaction between solutions of sodium chloride and lead (II) nitrate. The three types of equations are:

- **Balanced formula equation**: (shows everything balanced)
  $2NaCl_{(aq)} + Pb(NO_3)_{2(aq)} \rightarrow 2NaNO_{3(aq)} + PbCl_{2(s)}$

- **Total ionic equation**: (ionize substances that are strong electrolytes)
  $2\ Na^+_{(aq)} + 2\ Cl^-_{(aq)} + Pb^{2+}_{(aq)} + 2\ NO_3^-{}_{(aq)} \rightarrow 2\ Na^+_{(aq)} + 2\ NO_3^-{}_{(aq)} + PbCl_{2(s)}$

- **Balanced net ionic equation**: (what is left after canceling common terms—spectator ions)
  $2\ Cl^-_{(aq)} + Pb^{2+}_{(aq)} \rightarrow PbCl_{2(s)}$

Identify the spectator ions in the equation above? Na^+ and NO_3^-

Example 1:
Solutions of iron (III) nitrate and potassium hydroxide are mixed.

Balanced formula equation:

Total ionic equation:

Balanced net ionic equation:

Example 2:
Magnesium ribbon reacts with hydrochloric acid.

Balanced formula equation:

Total ionic equation:

Balanced net ionic equation:

Example 3:
Solutions of acetic acid and lithium bicarbonate are mixed.

Balanced formula equation:

Total ionic equation:

Balanced net ionic equation:

Example 4:
Solutions of magnesium chloride and calcium nitrate are mixed.

Balanced formula equation:

Total ionic equation:

Balanced net ionic equation:

Name _____

Period _____

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CONCLUSION QUESTIONS

Write the net ionic reaction for each of the following chemical reactions on your own paper. Be sure to show the balanced formula equation, total ionic equation and net ionic equation for each of the following in order to receive full credit. Be sure to put in state symbols for each component and correct charges for ions where appropriate.

1. Solutions of barium nitrate and lithium chloride are mixed.
2. Copper metal is placed into a solution of silver nitrate.
3. Solid potassium chlorate decomposes with heat.
4. Solid sodium metal is placed into distilled water.
5. Chlorine gas is bubbled into a solution of magnesium bromide.
6. Methane gas is burned in the presence of oxygen gas.
7. Solutions of silver acetate and barium chloride are mixed.
8. Solutions of sodium bicarbonate and hydrochloric acid are mixed.
9. Solutions of ammonium perchlorate and barium hydroxide are mixed.
10. Solutions of tin (II) fluoride and lithium carbonate are mixed.