How to write a net ionic equation

Problem number: **6.022×10^{23}**

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This work sheet will help you prepare for the next series of labs involving aqueous reactions. The handout shows a method for developing a molecular, ionic, and net ionic equation from the reaction of two compounds. These reactions are discussed in your book in Chapter 4. There are two main types of reactions: double displacement and single displacement. In a double displacement reaction two compounds react; the anion of compound one displaces the anion of compound two, and two new compounds are formed. There are three types of reactions that are considered double displacement reactions: formation of a solid, formation of a gas, and formation of water. Single replacement reactions are also red-ox reactions. In a single replacement reaction, an element reacts with either the anion or the cation of an ionic compound to create and new element and a new ionic compound. (It could also happen with a molecular compound, but this is beyond the scope of this exercise).

Double displacement reactions: In the formation of a solid, the general pattern is 'ionic + ionic $\rightarrow$ new ionic + solid ionic'. This means metal cation #1 + anion #1 and metal cation #2 + anion #2 react. You use solubility rules to determine if the reaction produces a solid.

In the formation of a molecule (water!), the reactants are either a strong acid and a strong base or a weak acid and a strong base. (One can actually have any combination of these two components). The products are always a salt, and water. Strong acids are $HCl_{(aq)}$, $HBr_{(aq)}$, $HCl_{(aq)}$, $H_2SO_{4(aq)}$, HNO_3, $HClO_4$, and $HClO_3$. Strong bases are LiOH, NaOH, KOH, RbOH, CsOH, $Ba(OH)_2$, and $Sr(OH)_2$. Any compound containing hydroxide will react with an acid; the phase of the base does not matter. Oxides like Na_2O and BaO will also react as bases. Most acids are weak, so learn the 7 strong acids listed above. Weak acids, however, do not dissociate completely and, therefore, have ionic and net ionic equations different from their strong acid cousins.

Gas formation reactions are a continuation of acid base reactions. The product is a gas, a salt, and water. This is not a combustion reaction! You need to know the four ions that lead to gas formation. They are carbonate (and hydrogen carbonate), sulfite (and hydrogen sulfite), sulfide (and hydrogen sulfide), and ammonium. Carbonates yield carbon dioxide, sulfites yield sulfur dioxide, and

sulfides yield dihydrogen sulfide when mixed with one of the seven strong acids. Ammonium (an acid) reacts with strong bases to yield ammonia gas.

Single replacement reactions: The general pattern is 'element + ionic compound → new element + new ionic compound'. The element could be a metal or a nonmetal!. We will use the activity series in your book to determine if the reaction occurs.

The questions listed below should help guide you through the process of writing the three types of equations (molecular [ME], ionic [IE], and net ionic equations [NIE]). **Although you do not have to answer each question to figure out the process, it is a good idea to do so.**

1 What is the correct formula for reactant 1?
2 What is the correct formula for reactant 2?
3 Identify your reactants. Is reactant 1 a weak acid or base, a strong acid, a soluble ionic compound, or a molecule (like water)? What is the phase of this compound? Is the reactant a solid, liquid, gas, or aqueous (a soluble ionic compound or a weak acid or base). Do the same for reactant 2.
4 Write the reactant side for the molecular equation.
5 If reactant 1 and/or reactant 2 are soluble ionic compounds, separate compound into ions (cations and anions) with correct charges and phases. Write these on the reactant side for the ionic equation. This part goes directly below the reactant side of the molecular equation. Remember that solids, liquids, gases, and weak acids do not break up into ions, but can undergo reactions. These stay as formulas on the reactant side [yes, even ionic compounds that are solids].
6 Write the full chemical formula for each on the product side of the molecular equation. Balance this equation.
7 Evaluate the phases of the product. Does a precipitate form? Does a gas form? Does water form? Was an electron lost or gained? Is the product a solid, liquid, or gas? Use solubility rules and reaction profiles to identify products. Make sure that you put in phases.
8 Break the new compounds apart, if they are not a weak acid, a gas, a molecule, or a precipitate. Write these ions and the other products on the product side of the ionic equation. Remember to transfer you phases to this part of the ionic equation. At this point you have completed two equations: the molecular and the ionic equations.
9 Are there any ions that are the same (un-reacted) on both sides? Eliminate them; they are spectator ions.
10 Write the balanced net ionic equation with correct charge and phase.

11 Single replacement reactions are written in a similar fashion, except that we are reacting an element and an ion and making a new element and a new ion.

Watch out! Some of these reactions could form other products beside the product of interest. Also, all of these reactions occur in water. If you have two solids, you will need to add water (even though water is not part of the reaction-or is it?) For example: What if your sample reactants are magnesium metal + silver(II) carbonate? Both of these substances are solids. If you were to dump them in a test tube filled with water, a reaction will occur. The silver ion will form in very, very small quantities. Each time the cation forms, it will react with a magnesium atom on the surface of the metal and silver metal will precipitate out. A reaction does happen-it just happens slowly.

NOTE-these reactions should all give some kind of product. If by accident I gave you a reaction that does not give products, you need to see me to get a new set of reactants. Writing 'no reaction' will result in a zero for that part. The goal of this practicum is to give you experience in writing the NIE's for basic types of reactions.

You should work in a group for this lab. Make sure that every one in the group has a unique set of reactants for the problem set. You can help each other. Hopefully, you will see at least three or four different gas producing reactants and weak acids by working together with other students.

The five types of reactions with YOUR combination of reactants are:
Formation of a solid: *Sodium cyanide + ruthinium(III) nitrite*
Formation of a gas: *hydroastatinic acid+ radium carbonate*
Reaction of a strong acid with a strong base: *francium hydroxide +hydroastatinic acid*
Reaction of a weak acid with a strong base: *oxalic acid + Francium hydroxide*
Single displacement: *iron + mercury(II) astatinide*

To complete this lab assignment, write the molecular, ionic and net ionic equation for each reaction showing the correct phase and charge for each reactant and product in your lab book. Include all charges, phases, and coefficients for each reaction when appropriate. Clearly label the type of reaction.