

ACTIVITY 4— CHEMICAL EQUATIONS

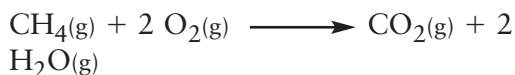
Background Information

A **chemical equation** is a shorthand description of a chemical reaction that uses symbols and formulas to represent the elements and compounds that are involved. Chemical equations provide a wealth of information about reactions. The numbers of atoms of each element before and after the reaction must be equal in a properly balanced chemical equation. We place **stoichiometric coefficients** in front of formulas in chemical equations to balance the equations. These coefficients represent the molar ratios of reactants and products.

Common Types of Chemical Reactions

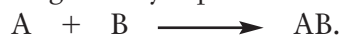
Chemical reactions occur in several different forms. Knowing the type of reaction is useful when you write chemical equations. Most chemical reactions can be placed into one or more of the following five categories:

1. Combustion reactions. Organic hydrocarbons can burn in the presence of oxygen to produce CO_2 and water. The burning of methane (CH_4), the chief component of natural gas, is an example of a combustion reaction:

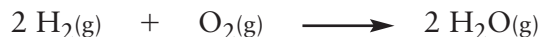


2. Synthesis reactions. Also called *combination reactions*, these reactions occur

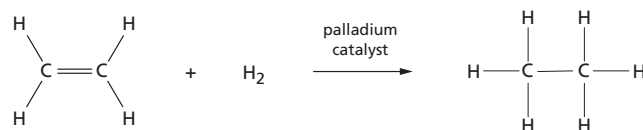
when one element or compound combines with another element or compound to produce a new compound. This process can be generally represented as:



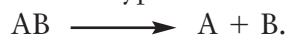
When H_2 gas reacts with O_2 , water is synthesized:



Hydrogen can also react with ethylene (C_2H_4), in the presence of palladium catalyst, to produce ethane (C_2H_6):



3. Decomposition reactions. When a compound has broken down into two or more simpler materials, a decomposition reaction has occurred. The general equation for this type of reaction is:



An example of a decomposition reaction is the decomposition of dinitrogen pentoxide:



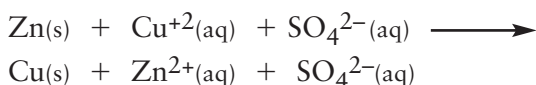
4. Single-displacement reactions. When a metal will react with an acid and produce hydrogen gas we can say that one element displaced another element from a compound. This phenomenon is commonly called a single-displacement reaction.

Oxidation-reduction reactions are also classified as single-displacement reactions. These occur if you place a metal strip into

a metallic ionic solution. A good example is when zinc metal is placed in a solution of copper (II) sulfate. Note that the copper is reduced and plates out on the zinc strip. The general equation for this reaction is:



The *total ionic equation*:

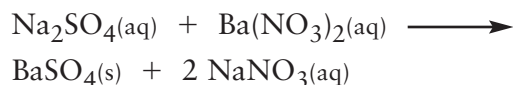


The sulfate ion does not do anything in the reaction, so you can remove the sulfate ion (called the *spectator ion*) from the equation to write the *net ionic equation*:

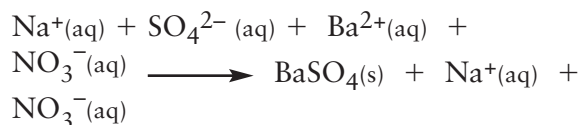


Single-displacement reactions are used to identify which elements will be displaced from its compounds by other metals. This order of reactivity is often called the *activity series* of metals.

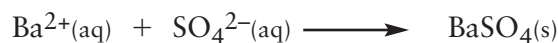
5. Double-displacement reactions (also called metathesis). These reactions usually involve ionic solutions. The cations exchange their anion partners in the reaction. A reaction has occurred if you see a solid dissolve, a precipitate form, or a gas evolve. If you mix a sodium sulfate solution with a barium nitrate solution, a white precipitate of barium sulfate will form. The general equation for this reaction is:



The total ionic equation:



Note that the equation is balanced with a net charge of zero on both sides. Note also that the sodium and nitrate ions are spectators in this reaction and thus the net ionic equation is:



If magnesium hydroxide and hydrochloric acid are mixed together, the solid magnesium hydroxide dissolves in the acid solution and produces water and magnesium chloride. Another example, as seen before, is the addition of an acid to sodium hydrogen carbonate. This produces carbon dioxide gas, water, and a soluble salt.

Knowing the solubility charts comes in handy for predicting the identity of precipitates formed when two ionic solutions react. Double-displacement reactions are used to separate ions, for qualitative analysis, and in some cases, for neutralizing acid spills.