AP Chemistry

Active Learning Activity: Net Ionic Equations

Net ionic equations are an essential skill for AP Chemistry students. Net ionic equations are generally used to represent double displacement reactions, including precipitation reactions and acid-base reactions, as well as single replacement reactions. Unless otherwise noted, assume that all reactions occur and that water is the solvent.

*Part 1: Representing Compounds in Aqueous Solution*

You do not have access to a solubility table during AP Chemistry exams, so it is essential that you memorize the solubility rules as well as the common strong acids and bases. The following guidelines will help you to represent each substance as it is found in aqueous solution.

1. If a substance is a covalent species, it will be represented as a molecule and remain as a molecule in water.

Examples:

CO2(g), H2O(l)

1. If the compound is a soluble ionic compound, it needs to be represented as dissociated ions. Make sure ion charges, subscripts and coefficients are represented appropriately. (States of matter are not required, but may be helpful.)

Example:

Na2SO4(aq) should be written as 2 Na+(aq) + SO42-(aq)

1. If the compound is a precipitate or an insoluble ionic compound, it will be represented as a neutral compound in the solid state.

Example:

Solid silver chloride in water would be written as AgCl(s)

1. Strong acids and bases are written as dissociated ions, but weak acids and bases are represented in their molecular forms. (Memorize the common strong acids!)

Example:

Hydrochloric acid (a strong acid) should be written as H+(aq) + Cl-(aq) but chlorous acid (a weak acid) would be written as HClO2(aq)

Note: Sulfuric acid is a strong acid only for the dissociation of the first hydrogen ion. It is best represented as H+(aq) + HSO4-(aq)

**Practice Problems:**

1. A solution of potassium bromide
2. A solution of ethanol
3. A precipitate of lead(II) sulfide
4. An aqueous solution of ammonia
5. A lithium nitrate solution
6. Liquid bromine
7. Nitric acid
8. Acetic acid
9. Nitrogen dioxide gas
10. A precipitate of iron(III) hydroxide

*Part 2: Writing Complete Ionic Equations*

Complete ionic equations show all of the species present during the reaction as they occur in solution. Although states of matter are often included, strictly speaking they are not necessary. It is important, however, to include correct ion charges and coefficients for all the ions from a dissociated soluble ionic compound. Students often find it can be helpful to write a “complete molecular equation” that shows the formulas of each species before writing the complete ionic equation—this step is optional.

Example 1. Solutions of sodium chloride and silver nitrate are combined.

CIE #1 Na+(aq) + Cl-(aq) + Ag+(aq) + NO3-(aq) → AgCl(s) + Na+(aq) + NO3-(aq)

1. What class of reaction is this?
2. How can you identify the precipitate when the state of matter is not provided?

Example 2. A piece of aluminum foil is submerged in a solution of copper(II) chloride.

CIE #2 2Al(s) + 3Cu2+(aq) + 6 Cl-(aq) → 2Al3+(aq) + 3Cu(s) + 6 Cl-(aq)

1. What class of reaction is this?
2. What happens to the oxidation number of the aluminum metal as the reaction proceeds?

Example 3. Equal volumes of 0.1M solutions of hydrobromic acid and potassium hydroxide are mixed.

CIE #3 H+(aq) + Br-(aq) + K+(aq) + OH-(aq) 🡪 H2O(l) + K+(aq) + Br-(aq)

1. What class of reaction is this?
2. List the common strong acids:
3. List the common strong bases:

**Practice Problems:**

1. A solution of iron(III) acetate is added to a solution of lithium hydroxide.
2. Bromine gas is bubbled through a solution of sodium chloride.
3. A pellet of sodium hydroxide is added to a solution of nitrous acid.

*Part 3: Net Ionic Equations and Spectator Ions*

Net ionic equations emphasize the species that are actually involved in chemical change. Spectator ions, which are the same on both sides of the reaction, are crossed out or omitted to write the net ionic equation. If there are no spectator ions present, then a NIE cannot be written for that particular reaction. Again, states of matter are helpful, but not required.

Example 1. Solutions of sodium chloride and silver nitrate are combined.

CIE #1 Na+(aq) + Cl-(aq) + Ag+(aq) + NO3-(aq) → AgCl(s) + Na+(aq) + NO3-(aq)

NIE #1 Cl-(aq) + Ag+(aq) → AgCl(s)

1. Identify the spectator ions in this reaction:

Example 2. A piece of aluminum foil is submerged in a solution of copper(II) chloride.

CIE #2 2Al(s) + 3Cu2+(aq) + 6 Cl-(aq) → 2Al3+(aq) + 3Cu(s) + 6 Cl-(aq)

NIE #2 2Al(s) + 3Cu2+(aq) → 2Al3+(aq) + 3Cu(s)

1. Identify the spectator ions in this reaction:
2. Identify some ions that are likely to be spectator ions:

Example 3. Equal volumes of 0.1M solutions of hydrobromic acid and potassium hydroxide are mixed.

CIE #3 H+(aq) + Br-(aq) + K+(aq) + OH-(aq) → H2O(l) + K+(aq) + Br-(aq)

NIE #3: H+(aq) OH-(aq) → H2O(l)

1. All reactions between a strong acid and a strong base have the same net ionic equation. Write it here:

**Practice Problems:**

1. Write NIE for the complete ionic equations you wrote in #18 and 19. List any spectator ion(s) present.

s

1. There is no NIE for the reaction you wrote in #20. Explain why.