# Acid-Base Reactions

**Unit 14A:** Aqueous Reactions/Descriptive Chemistry and Acids & Bases

### Knowledge/Understanding Goals:

* weak vs. strong acids & bases

### Skills:

* write neutralization reactions for acid-base reactions

### Notes:

According to Svante Arrhenius’s definitions:

* acids produce \_\_\_\_\_\_\_\_\_\_\_ in aqueous solutions
* bases produce \_\_\_\_\_\_\_\_\_\_\_ in aqueous solutions

\*Note that the difference between \_\_\_\_\_\_\_\_\_ and \_\_\_\_\_\_\_\_. A compound does not have to donate H+ or OH- ions into solution to be an acid or a base, it may also cause these ions to form via equilibrium reactions with water.

NaOH → Na+ + OH- vs NH3 +H2O NH4+ +OH-

titration: measuring the volume of a standard solution used to \_\_\_\_\_\_\_\_\_\_\_\_\_\_ a known volume of an \_\_\_\_\_\_\_\_\_\_\_ solution. The concentration of the unknown solution can then be calculated using \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ (the moles of standard solution added must equal the moles of H+ or OH− neutralized).

strong acid: an acid that ionizes \_\_\_\_\_\_\_\_\_\_\_\_\_ in water.

HCl (aq) → H+ (aq) + Cl− (aq)

Any acid with a negative *pKa* value (see reference table in your textbook) is a strong acid. Memorize the following strong acids:

weak acid: an acid that ionizes only \_\_\_\_\_\_\_\_\_\_\_ in water.

HF (aq)  H+ (aq) + F− (aq)

Assume that any acid you will see on the AP Chemistry exam is a weak acid unless it is one of the strong acids listed above.

strong base: a base that dissociates \_\_\_\_\_\_\_\_\_\_\_\_\_ in water.

NaOH (aq) → Na+ (aq) + OH− (aq)

Any base whose conjugate acid has a *pKa* value greater than 14 is a strong base. All \_\_\_\_\_\_\_\_\_\_ oxides and hydroxides of group I and group II metals are strong bases.

(Except that aqueous Mg(OH)2 *acts* like a weak base because its \_\_\_\_\_\_\_\_\_\_\_\_\_\_ is so \_\_\_\_\_ that the concentration of OH− ions in solution is similar to that produced by a weak base.)

weak base: a base that ionizes only \_\_\_\_\_\_\_\_\_\_\_ in water. Weak bases react with H2O, creating the conjugate acid and OH−.

NH3 (aq) + H2O (ℓ)  NH4+ (aq) + OH− (aq)

Assume that any base you see on the AP Chemistry exam is a weak base unless it is one of the strong bases listed above.

**Ions in Solution**

Strong acids and bases are strong \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_, meaning that they ionize to produce a large number of ions in water, and the resulting solution is a good \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ of electricity.

Weak acids and bases ionize only partially. This often means that the resulting solution is a \_\_\_\_\_\_\_\_ electrolyte (poor conductor of electricity).

However, note that if the weak acid or base is itself an \_\_\_\_, the solution will be a \_\_\_\_\_\_\_\_\_\_\_ electrolyte regardless of the amount of dissociation of the acid or base.

H2PO4- (aq) + H2O (l)HPO42- (aq) + H3O+(aq)

Note that the \_\_\_\_\_ produced by the dissociation of \_\_\_\_\_\_\_\_\_ acids and bases (*e.g.,* Li+, Na+, K+, Ca2+, Sr2+, Ba2+, Cl−, Br−, I−, NO3−, ClO4−, SO4−) act as \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_, because their conjugate acids & bases do not form in aqueous solution. (Dissociation heavily favored)

Note, however, that anions whose conjugates are weak acids (*e.g.,* F−, CH3COO−, CO32−, PO43−, *etc.*) are \_\_\_\_\_\_\_\_\_. Similarly, cations whose conjugates are weak bases (*e.g.,* NH4+) are \_\_\_\_\_\_\_\_\_ in solution. Note also that cations whose hydroxides are \_\_\_\_\_\_\_\_\_\_\_ are acidic in solution because they remove OH− from solution.

Thus, salts formed from \_\_\_\_\_\_ acid or base reactions will influence the final pH of the solution.

* A salt that is comprised of an acidic cation (such as NH4+) and a spectator anion (such as Cl−) will be \_\_\_\_\_\_\_\_ in solution.
* A salt that is comprised of a spectator cation (such as Na+) and a basic anion (such as CO32−) will be \_\_\_\_\_\_\_\_ in solution.
* A cation resulting in an insoluble hydroxide salt will be \_\_\_\_\_\_\_\_ in solution.

**Acid-Base Reactions**

### Strong Acid/Strong Base

Because strong acids hydrolyze completely in water, the net ionic reaction for any strong acid/strong base reaction is:

If you write out the detailed ionic equation, you will see that all of the other ions are spectators, as in the following example:

HNO3 (aq) + NaOH (aq) → NaNO3 (aq) + H2O (ℓ)

### Weak Acid/Strong Base

1. Write the weak reaction (ionization of the weak acid) first.
2. Write the reaction for the H+ combining with OH− from the strong base to form H2O.
3. Combine the two reactions.
4. Cancel out H+ from both sides.

For example, in the reaction between HF (weak acid) and NaOH (strong base):

HF (aq)  H+ (aq) + F− (aq)

### Strong Acid/Weak Base

1. Write the weak reaction (reaction of the weak base with water) first.
2. Write the reaction for the OH− combining with H+ from the strong acid to form H2O.
3. Combine the two reactions.
4. Cancel out OH− and H2O from both sides.

For example, in the reaction between HCl (strong acid) and NH3 (weak base):

NH3 (aq) + H2O (ℓ)  NH4+ (aq) + OH− (aq)