Chapter 16 Acids and Bases

16.1 Properties of Acids and Bases

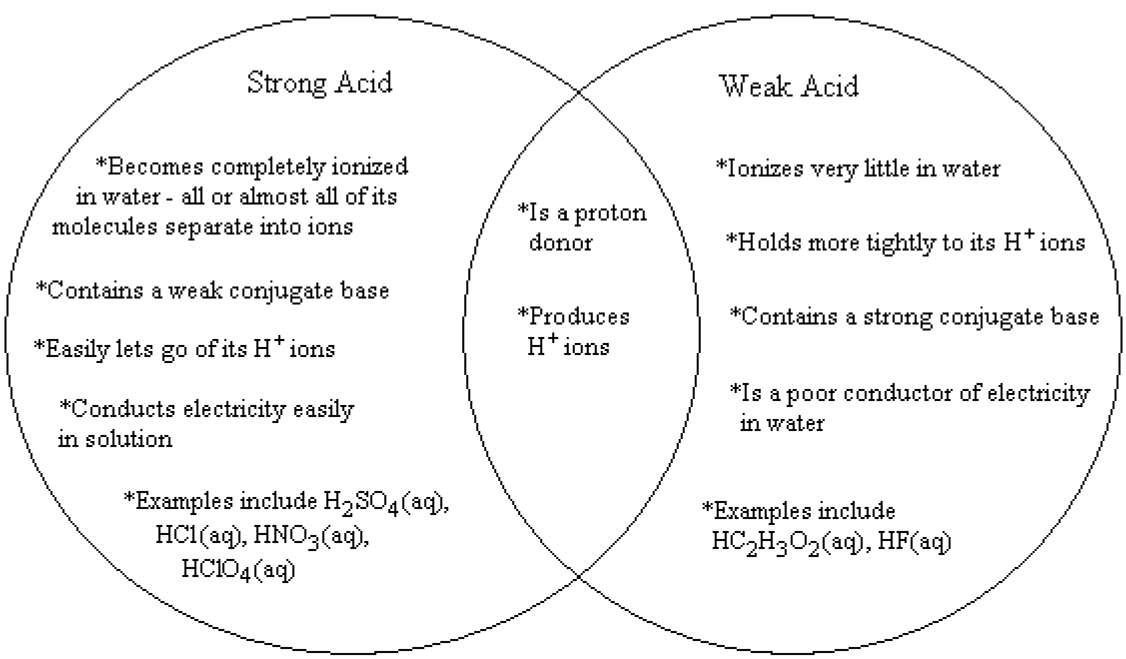
Key Terms

acids	bases	Brønsted-Lowry model
Arrhenius concept of acids and bases	conjugate acid	conjugate base
conjugate acid–base pair	hydronium ion	completely ionized (completely dissociated)
strong acid	weak acid	diprotic acid
oxyacids	organic acids	carboxyl group
amphoteric substance	ionization of water	ion-product constant

Summary

The *Arrhenius concept of acids and bases* defines *acids* as substances that produce hydrogen ions in aqueous solutions. *Bases,* on the other hand, produce hydroxide ions. In the *Brønsted-Lowry model,* an *acid* is defined as a proton (H^+) donor, and a *base* is a proton acceptor. A *conjugate acid* is formed when a proton is transferred to the base. A *conjugate base* is everything that remains of the acid molecule after the proton is lost. Two substances related in this way are called a *conjugate acid–base pair.*

Acids are classified as strong or weak depending on a number of characteristics.



Water can act as either an acid or a base. Such a substance is called an *amphoteric substance.* In pure water, the molecules transfer H^+ ions to produce tiny amounts of H_3O^+ and OH^-. The concentrations for these ions in pure water are always equal and are described by the *ion-product constant* for water K_w. K_w is determined by multiplying the concentrations of H_3O^+ and OH^- at 25°C. The number always equals 1.0×10^{-14} at 25°C.

16.2 Determining the Acidity of a Solution

Key Terms

pH scale | indicators | indicator paper
pH meter

Summary

The *pH scale* represents the acidity of a solution by describing the concentration of H^+ in the solution. Since this number is typically quite small, scientists express it using the pH scale, which is the log of the number multiplied by –1. The equation for calculating pH is pH = –log[H^+]. The lower the pH for a solution, the higher its acidity.

The traditional way of determining the pH of a solution is by using *indicators,* which are substances that turn different colors in acidic and basic solutions. *Indicator paper* is coated with a combination of indicators. It turns a specific color for each pH value. A *pH meter* can measure pH electronically.

If we know a solution contains 1.0 *M* HCl, we can find the pH of the solution by understanding that a 1.0 *M* HCl solution contains H^+ and Cl^- ions rather than HCl molecules. This amount of HCl contains 1.0 *M* H^+, and the pH can be calculated with the following equation:

$$\text{pH} = -\log[H^+] = -\log[1.0] = 0$$

16.3 Titrations and Buffers

Key Terms

neutralization reaction | titration | standard solution
buret | stoichiometric (equivalence) point
titration curve (pH curve) | buffered solution

Summary

To analyze the acid or base content of a solution, chemists often perform a titration. A *titration* involves adding a measured volume of a solution of known concentration (the titrant) into the solution being analyzed (the analyte). The titrant contains a substance that reacts in a known way with the analyte. The titrant is added slowly to the analyte until all of the titrant and analyte have reacted. This point is called the *stoichiometric point,* or *equivalence point,* for the titration. For an acid–base titration, the equivalence point can be determined by using a pH meter or indicator. In the titration of a strong acid and a strong base, the equivalence point occurs when an equal amount of H^+ and OH^- have reacted so that the solution is neutral (pH = 7).

A *buffered solution* undergoes only a very slight change in pH when a strong acid or base is added to it. A solution is buffered by the presence of a weak acid and its conjugate base (or vice versa). The buffer resists changes in pH by reacting with any added H^+ or OH^- so that these ions do not form. Any added H^+ reacts with the base. Any added OH^- reacts with the weak acid.

Additional Active Reading Questions

1. Define an acid and a base according to the Brønsted-Lowry model.
2. Name two examples of a weak acid.
3. What is the term for a substance that can act as either an acid or a base?
4. What does a low pH number for a solution indicate?
5. What is a pH indicator?
6. Define *titration.*
7. What is a buffered solution?