

XVI. Acids and Bases (Chapter 8)

A. The Bronsted-Lowery Definition

1. There are many definitions for acids.

a) The Bronsted-Lowery definition is useful for us:

Acids- H^+ donor. (Note: The hydrogen ion H^+ is referred to as a "proton" since this ion consists of a single proton. Therefore, acids are also referred to as "proton donors". This is not to be confused with thinking that the ion comes from a nucleus of an atom.)

Bases- H^+ acceptors.

2. Some common acids:

a) HCl - muriatic acid, hydrochloric acid; found in the stomach.

b) H_2SO_4 - sulfuric acid; found in car batteries.

c) $HC_2H_3O_2$ - acetic acid; found in vinegar.

d) H_3PO_4 - phosphoric acid; found in soft drinks.

e) HNO_3 - nitric acid; used in industry.

3. Acids give off H^+

a) Strong acids such as HCl give off H^+ simply by adding it to water:



b) Weak acids such as $HC_2H_3O_2$ do not give off H^+ as easily when added to water.

4. Some common bases:

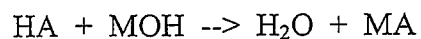
a) $NaOH$ - sodium hydroxide, lye; found in drain cleaners.

b) KOH - potassium hydroxide.

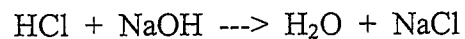
c) $Mg(OH)_2$ - magnesium hydroxide, milk of magnesia.

B. Acid/Base Reactions.

1. General reaction:



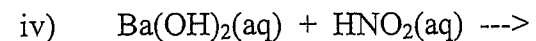
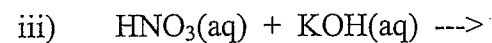
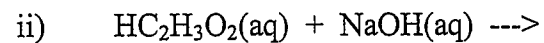
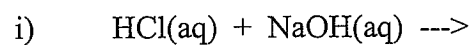
a) Example:



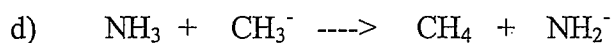
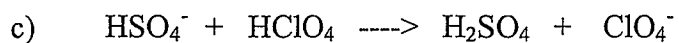
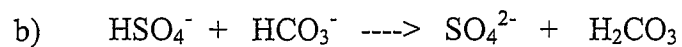
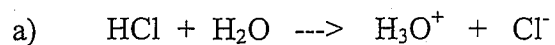
2. Reactions between acids and bases: neutralization.

a) The formation of water drives the reaction towards completion.

b) Complete the following molecular equations, then write the net-ionic equations:



3. For the following reactions identify the conjugate acid/base pairs.



4. a) What is the conjugate base for the HCO_3^- ion? (What does the hydrogen carbonate ion turn into upon acting as an acid?)

b) What is the conjugate acid of water? (What does water turn into when it acts as a base?)

c) What is the conjugate base of water?

d) What is the conjugate acid of NH_3 ?

e) What is the conjugate base of NH_3 ?

C. The pH of Strong Acids

1. Evaluate the following:

a) $\log 1 =$ $10^x = 1$ $x =$

b) $\log 10 =$ $10^x = 10$ $x =$

c) $\log 100 =$ $10^x = 100$ $x =$

d) $\log 1000 =$ $10^x = 1000$ $x =$

e) $\log .1 =$ $10^x = .1$ $x =$

f) $\log .01 =$ $10^x = .01$ $x =$

g) $\log 4.71 =$

h) $\log (4.71 \times 10^1) =$

i) $\log (4.71 \times 10^2) =$

j) $\log (3.74 \times 10^{-4}) =$

k) $\log .0000571 =$

2. Evaluate the following:

a) $\text{antilog } 1 =$

d) $\text{antilog } 12.7 =$

b) $\text{antilog } 2 =$

e) $\text{antilog } -11.24 =$

c) $\text{antilog } -3 =$

f) $\text{antilog } -4.55 =$

3. pH is defined as: $\text{pH} = -\log [\text{H}_3\text{O}^+]$ where [] represent concentration in molarity.

a) Memorize the pH equation.

b) Calculate the pH for solutions containing the following $[\text{H}_3\text{O}^+]$.

$$[\text{H}_3\text{O}^+] = .1\text{M}$$

$$\text{pH} = -\log [\text{H}_3\text{O}^+] =$$

$$[\text{H}_3\text{O}^+] = .01\text{M}$$

$$[\text{H}_3\text{O}^+] = .001\text{M}$$

$$[\text{H}_3\text{O}^+] = .0001\text{M}$$

c) A solution of pH 1 contains ___ times (more/less) H_3O^+ than a solution of pH 2.

d) A solution of pH 1 contains ___ times (more/less) H_3O^+ than a solution of pH 3.

4. pH calculations for strong acids (HNO_3 , HCl) are easy since strong acids ionize 100% into hydronium ion. Calculate the pH for the following solutions:

a) $9.7 \times 10^{-3}\text{M HCl}$

b) $.015\text{M HCl}$.

c) $5.78 \times 10^{-5}\text{M HNO}_3$.

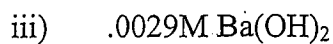
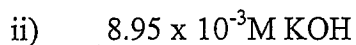
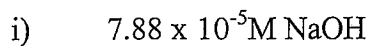
D. The pH of Strong Bases

1. pH calculations of strong bases take more work since the strong base dissociates into OH^- , not H_3O^+ .
2. The strong bases we will consider are Group IA metallic hydroxides (LiOH, NaOH, KOH) and $\text{Ba}(\text{OH})_2$.

3. $[\text{H}_3\text{O}^+]$ is related to $[\text{OH}^-]$ for aqueous solutions by the equation:

$$[\text{H}_3\text{O}^+][\text{OH}^-] = 1.00 \times 10^{-14}$$

- a) Memorize this equation
- b) Calculate the pH for the following solutions:



E. Calculating $[\text{H}_3\text{O}^+]$ and $[\text{OH}^-]$ from pH.

1. $[\text{H}_3\text{O}^+] = 10^{-\text{pH}}$ ($[\text{H}_3\text{O}^+] = \text{antilog } -\text{pH}$)

a) Memorize this equation.

2. Calculate $[\text{H}_3\text{O}^+]$ given the following information:

a) $\text{pH} = 7.00$

b) $\text{pH} = 11.00$

c) $\text{pH} = 3.31$

d) $\text{pH} = 9.65$

3. Once $[\text{H}_3\text{O}^+]$ is calculated, $[\text{OH}^-]$ can be calculated using the equation

$$[\text{H}_3\text{O}^+][\text{OH}^-] = 1.00 \times 10^{-14}.$$

4. A solution has a pH of 2.90. Calculate $[\text{H}_3\text{O}^+]$ and $[\text{OH}^-]$.

