AP Chemistry
Ms. Ye

Name _____
Date _____Block _____

Acids, Bases, and pH Overview

Acid/Base Definitions

- **Arrhenius Acid:** a substance that _____ when dissolved in water.
- **Arrhenius Base:** a substance that _____ when dissolved in water.

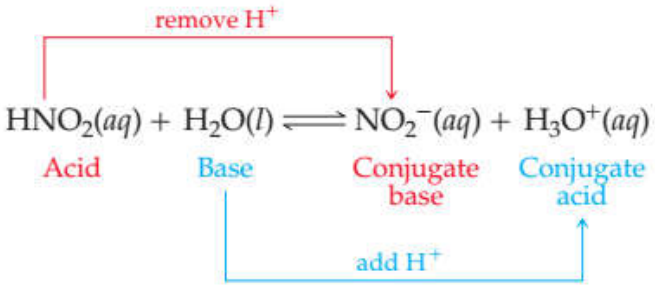
Arrhenius Acids/Bases are limited to aqueous solutions. Bronsted-Lowry Acid/Base definitions are more general.

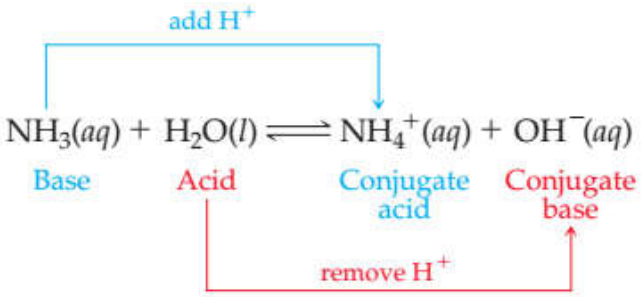
- **Bronsted-Lowry Acid:** a substance that is _____
- **Bronsted-Lowry Base:** a substance that is _____

- **Conjugate Acids and Bases**

Every acid has a conjugate base, every base has a conjugate acid

  - **Conjugate acid:** the species that is _____
  - **Conjugate base:** the species that is _____



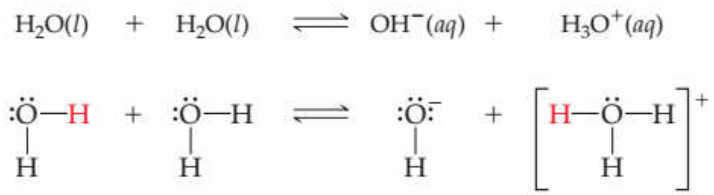


Ex:

1) Write the balanced equation for the dissociation of acetic acid, CH_3COOH, in water and identify the acid, base, conjugate acid, and conjugate base.

2) Write the balanced equation for the dissociation of phosphoric acid, H_3PO_4, in water and identify the acid, base, conjugate acid, and conjugate base.

- **Autoionization of Water:** water is an example of an **amphiprotic** substance and can act as either an acid or a base. Water can donate a proton to another molecule:



Note: H^+ and H_3O^+ are used interchangeably to represent the presence of hydrogen ions in solution.

- The equilibrium ion-product constant for water can be written as:

K_w =

- A solution in which _____ is said to be _____.

- **pH and pOH:**

The molar concentration of H+ in an aqueous solution is usually very small. For convenience, we therefore usually express [H+] in terms of pH ("potential for hydrogen").

pH = _____

Similarly, pOH is an expression of [OH-] in solution: **pOH** = _____

Logs are base 10, so to calculate concentration when given pH or pOH:

[H+]= _____ **[OH-]** = _____

Because **$K_w = [H^+][OH^-] = 1 \times 10^{-14}$**, _____

- **Strong Acids and Strong Bases**

Strong acids and bases will _____ in aqueous solution. Since the strong acid or base is usually the primary source of H+ or OH- in an aqueous solution, it is easy to calculate pH or pOH for them.

*****MEMORIZE THESE!**

Strong Acids	Strong Bases
Hydrochloric, HCl	Group 1A metal hydroxides (LiOH, NaOH, KOH, RbOH, CsOH)
Hydrobromic, HBr	Heavy group 2A metal hydroxides [$Ca(OH)_2$, $Sr(OH)_2$, $Ba(OH)_2$]
Hydroiodic, HI	
Chloric, $HClO_3$	
Perchloric, $HClO_4$	
Nitric, HNO_3	
Sulfuric, H_2SO_4	

Acid/Base Problem Set 1

Definitions and Conjugates

1. Answer the following questions about conjugates:
   a) Give the conjugate base of the following Bronsted-Lowry acids:

- HIO_3
- HPO_4^{2-}
- NH_4^+

   b) Give the conjugate acid of the following Bronsted-Lowry bases:

- O^{2-}
- SO_4^{2-}
- CH_3NH_2

2. For each of the following aqueous reactions, identify the acid, the base, the conjugate base, and the conjugate acid.
   a) $HF + H_2O \leftrightarrows F^- + H_3O^+$

   b) $H_2SO_4 + H_2O \leftrightarrows H_3O^+ + HSO_4^-$

   c) $HSO_4^- + H_2O \leftrightarrows SO_4^{2-} + H_3O^+$

3. Write balanced equations that describe the following reactions.
   a) The dissociation of perchloric acid in water

   b) The dissociation of propanoic acid ($CH_3CH_2CO_2H$) in water

   c) The dissociation of ammonium ion in water

4. Consider the reaction of acetic acid in water:

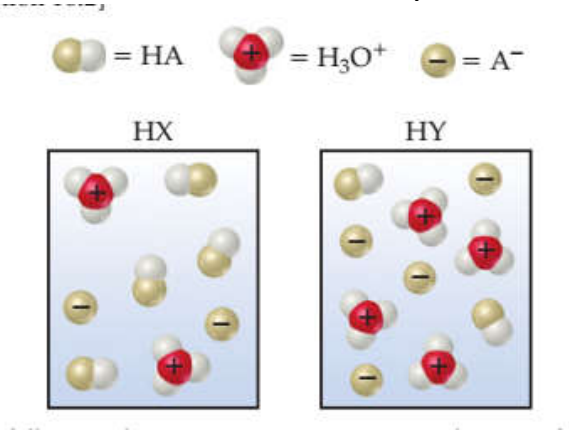
$HC_2H_3O_2\ (aq) + H_2O\ (l) \leftrightarrow C_2H_3O_2^-\ (aq) + H_3O^+\ (aq)$

a) Which two bases are competing for the proton?

b) Which is the stronger base?

c) In light of your answer to (b), why do we classify the acetate ion as a weak base? Use an appropriate reaction to justify your answer.

5. The following diagrams represent aqueous solutions of two monoprotic acids, HA (A = X or Y). The water molecules have been omitted for clarity.



a) Which is the stronger acid, HX or HY?

b) Which is the stronger base, X^- or Y^-?

c) If you mix equal concentrations of HX and NaY, will $HX_{(aq)} + Y^-_{(aq)} \leftrightarrow HY_{(aq)} + X^-_{(aq)}$ lies mostly to the right ($K_c > 1$) or to the left ($K_c < 1$)?

6. Anions containing hydrogen (for example HCO_3^- and $H_2PO_4^-$) usually show amphoteric behavior. Write equations illustrating the amphoterism of these two anions.

pH Definitions and Calculations

7. What is meant by pH?

8. Calculate the $[H^+]$ given a concentration of $[OH^-]$ of 1.44×10^{-9} M.

9. Calculate the pH of a solution with $[H^+] = 1.0 \times 10^{-2}$ M.

10. Calculate the pH of a solution with $[OH^-] = 1.93 \times 10^{-6}$.

11. Calculate the pH of a solution with a pOH of 9.47.

12. Find the pH, pOH, $[H^+]$, and $[OH^-]$ given the following:
    a) 1.0×10^{-3} M OH^-

    b) 10.0 M HCl

    c) pH of 7.41

13. Calculate the $[OH^-]$ of each of the following solutions at 25°C. Identify each solution as acidic, basic, or neutral.

a) $[H^+] = 1.0 \times 10^{-7}$ M

b) $[H^+] = 6.7 \times 10^{-4}$ M

c) $[H^+] = 1.9 \times 10^{-11}$ M

d) $[H^+] = 2.3$ M

14. The pOH of a sample of baking soda dissolved in water is 5.74 at 25°C. Calculate the pH, $[H^+]$, and $[OH^-]$ for this sample. Is the solution acidic or basic?