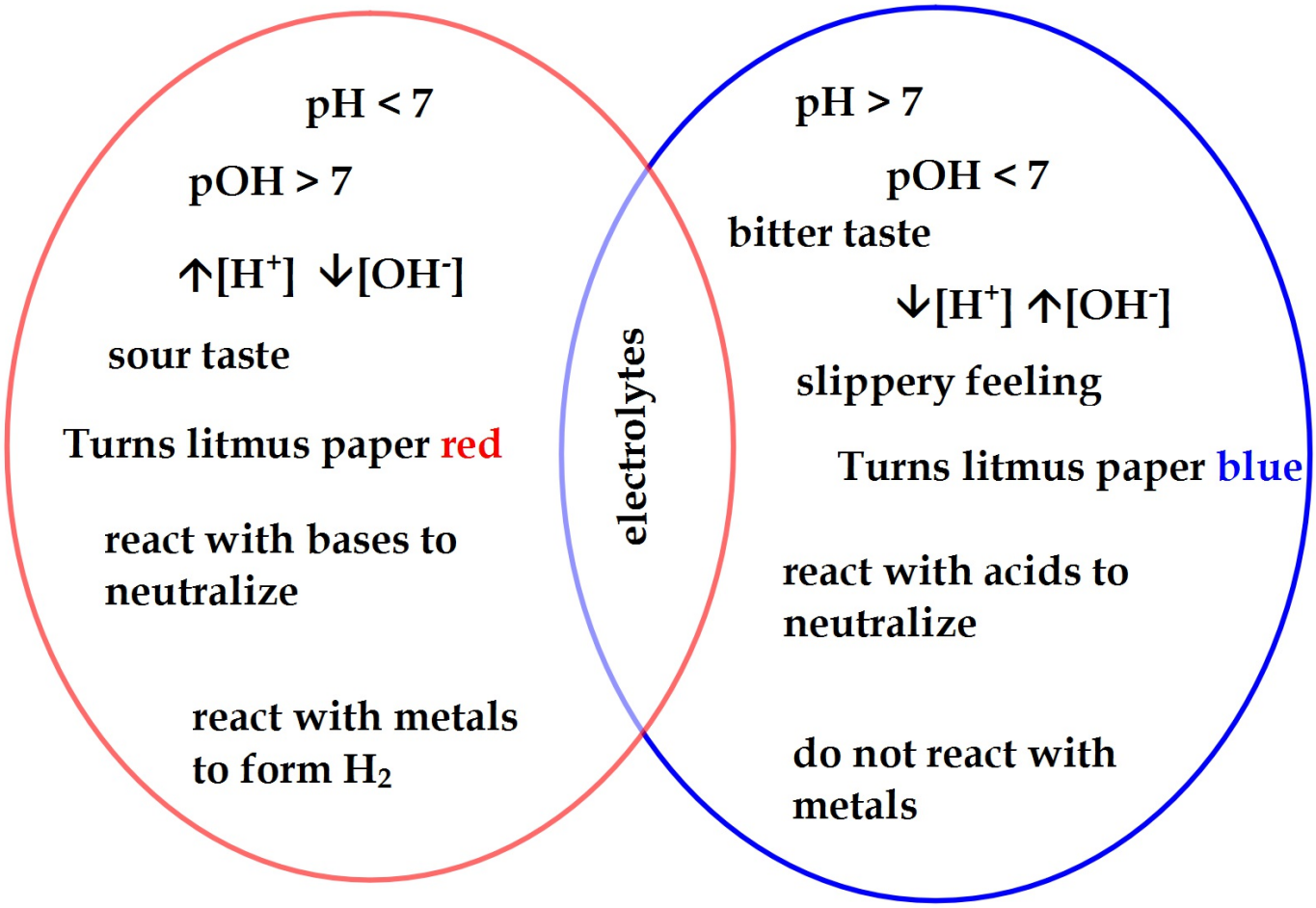
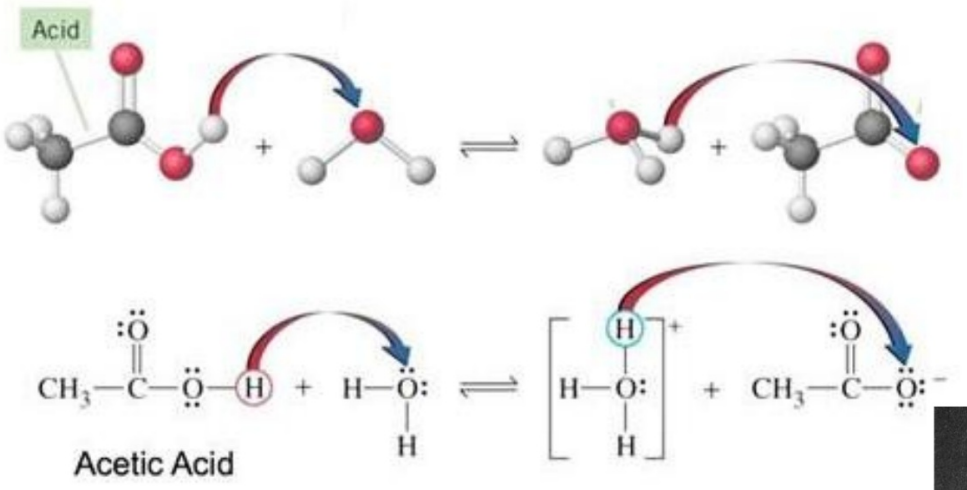
Lesson Overview
Acid-Base Models

Objective: The student will be able to (1) describe the Three Models of Acid-Base Theory, (2) classify strong and weak acids and bases, (3) discuss the extent of an acid-base reaction.

Properties of Acids and Bases



Acid-Base Model #1: Arrhenius Definition

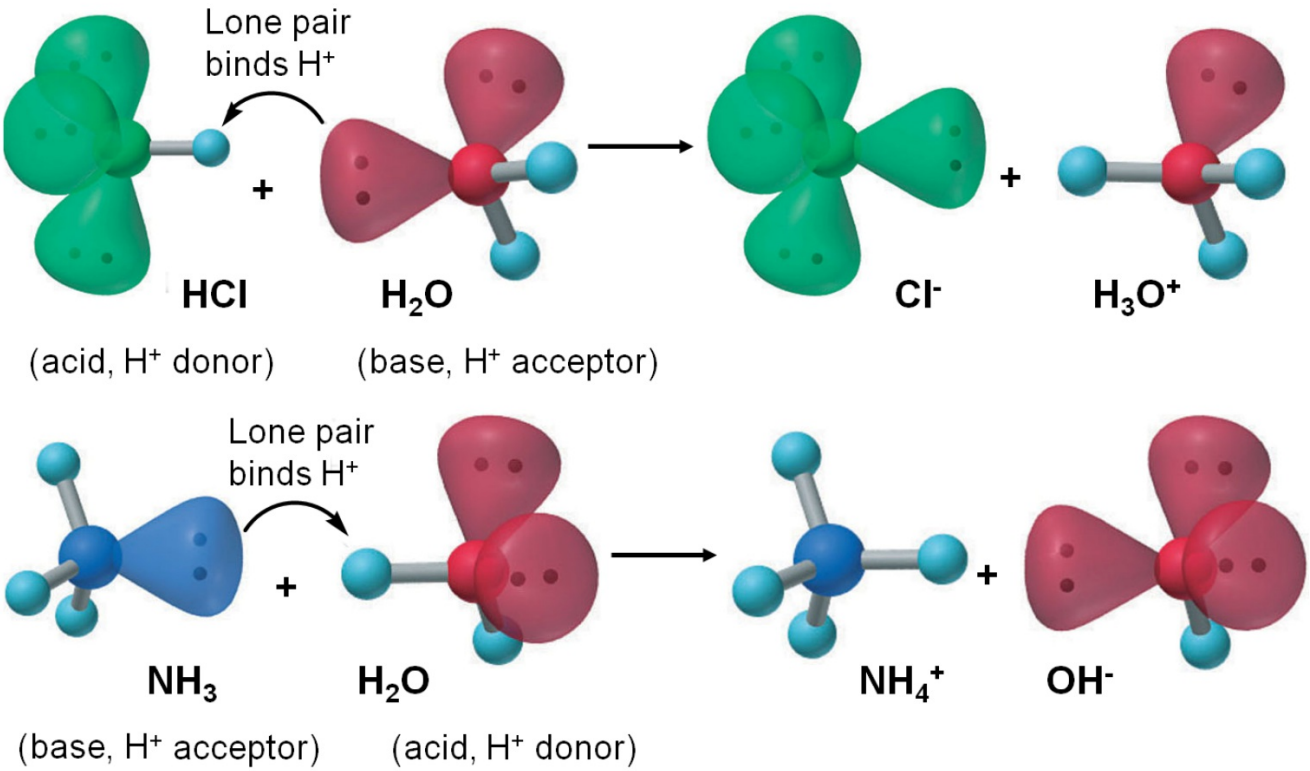


Acids produce H_3O^+

Bases produce OH^-

most restictive of the definitions

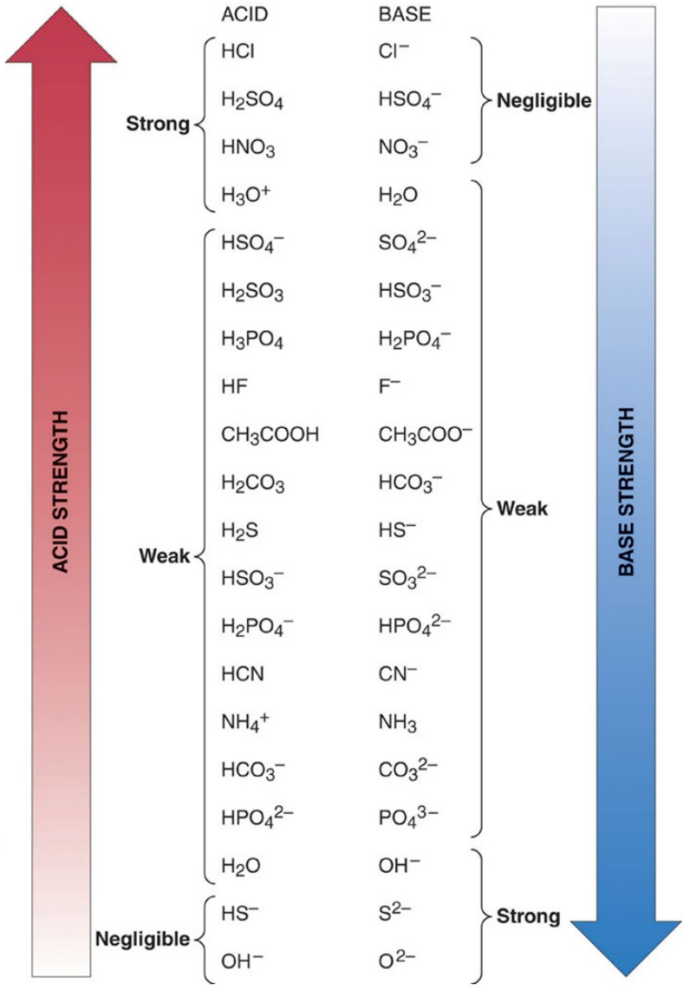
Acid-Base Model #2: Bronsted-Lowry Definition



Significance of the Bronsted-Lowry Definition

$H_2C_2O_4 + H_2O \leftrightarrows H_3O^+ + HC_2O_4^{-1}$

Acid-Base strength can be determined numerically by using tabular values. (Explain.)



Problem

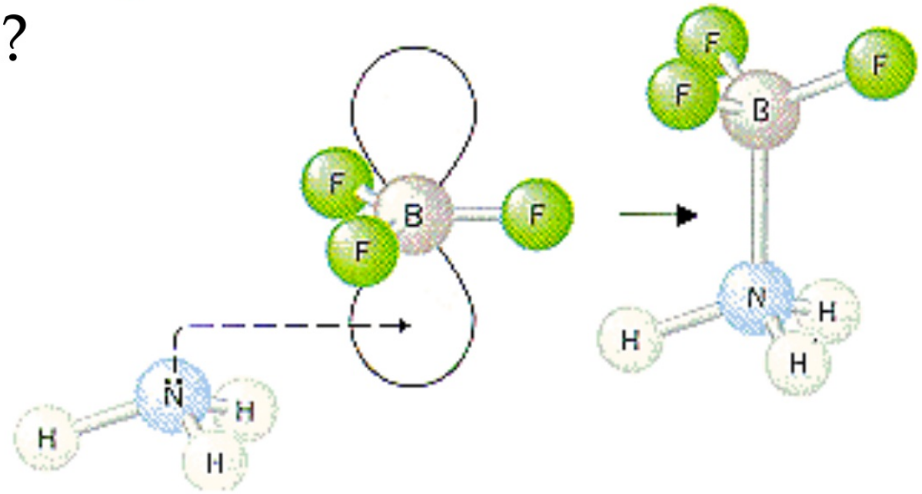
What is the conjugate acid when aqueous solutions of ammonia and hydrofluoric acid are mixed?

Acid-Base Model #3: Lewis Definition (G.N. Lewis)

Discusses the transfer of electrons

Problem

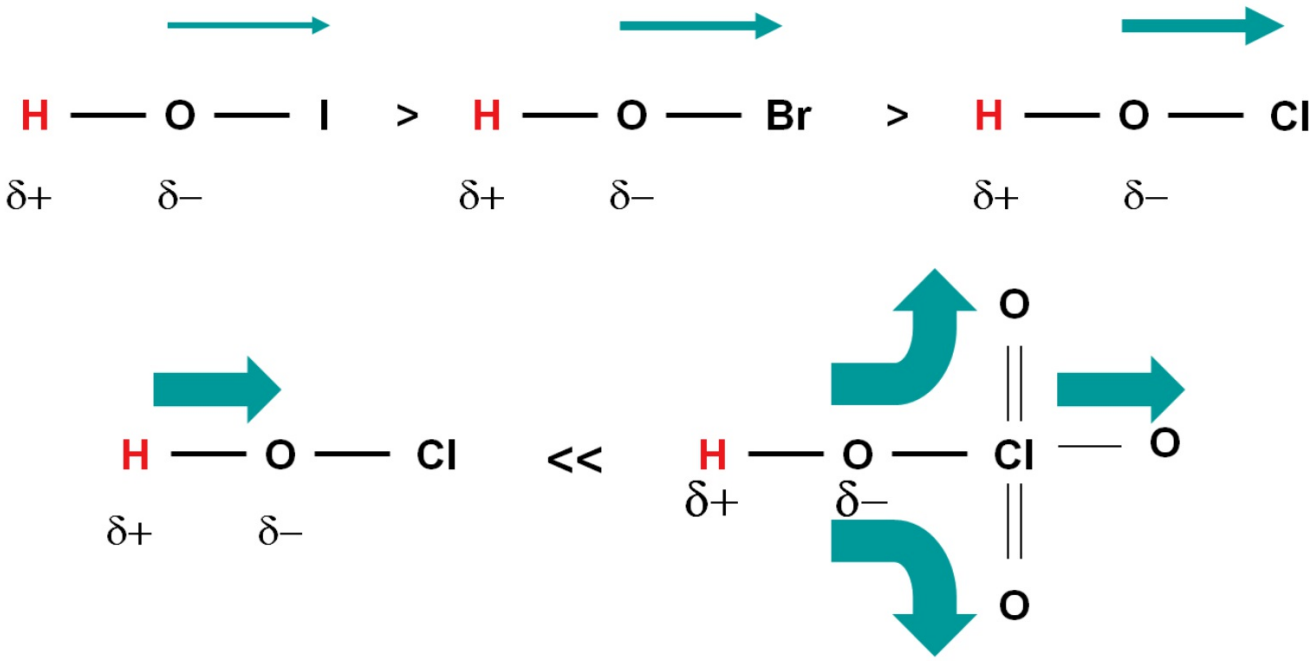
When BF_3 and NH_3 react, which is the Lewis acid?



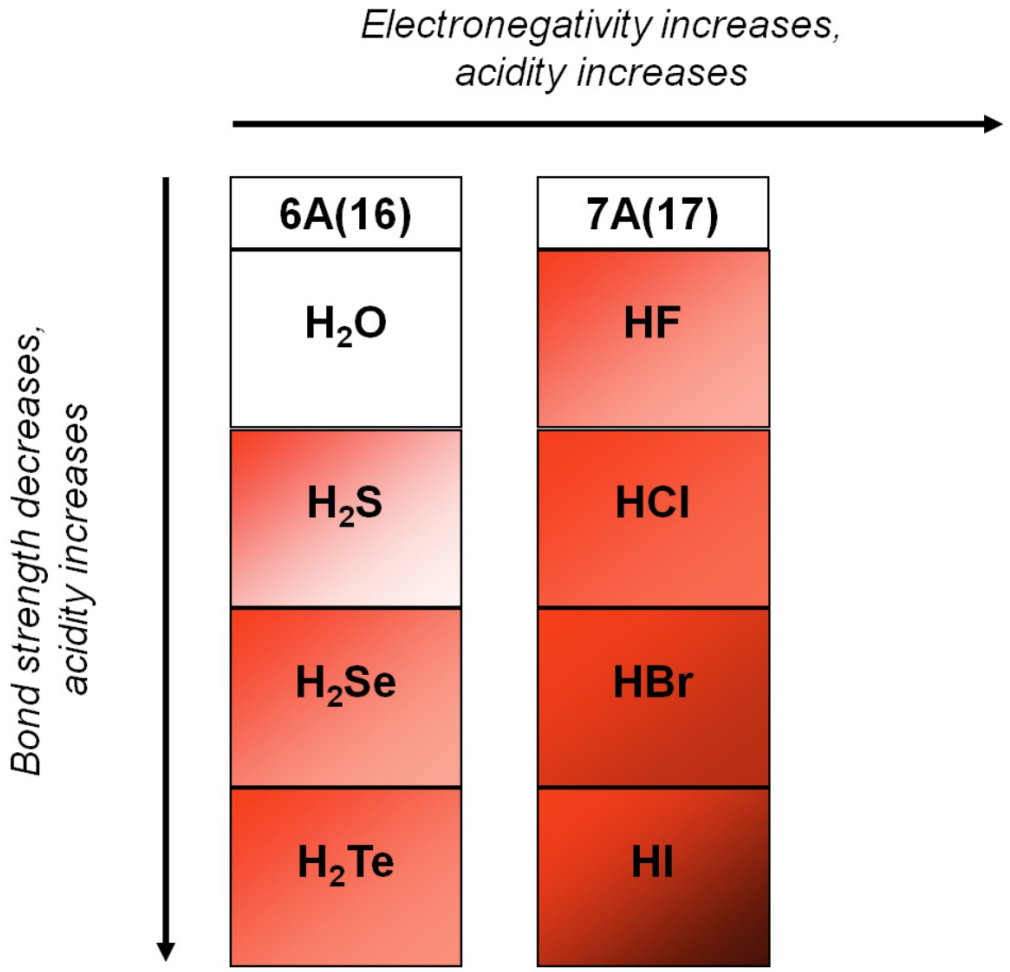
Relative Strength of Acids and Bases

	Strong	Weak
Acids	hydrohalic oxoacids	hydrohalic sans H-O oxoacids
Bases	R-OH and R-O where R is a IA or IIA metal	Electron-rich nitrogen with lone pair

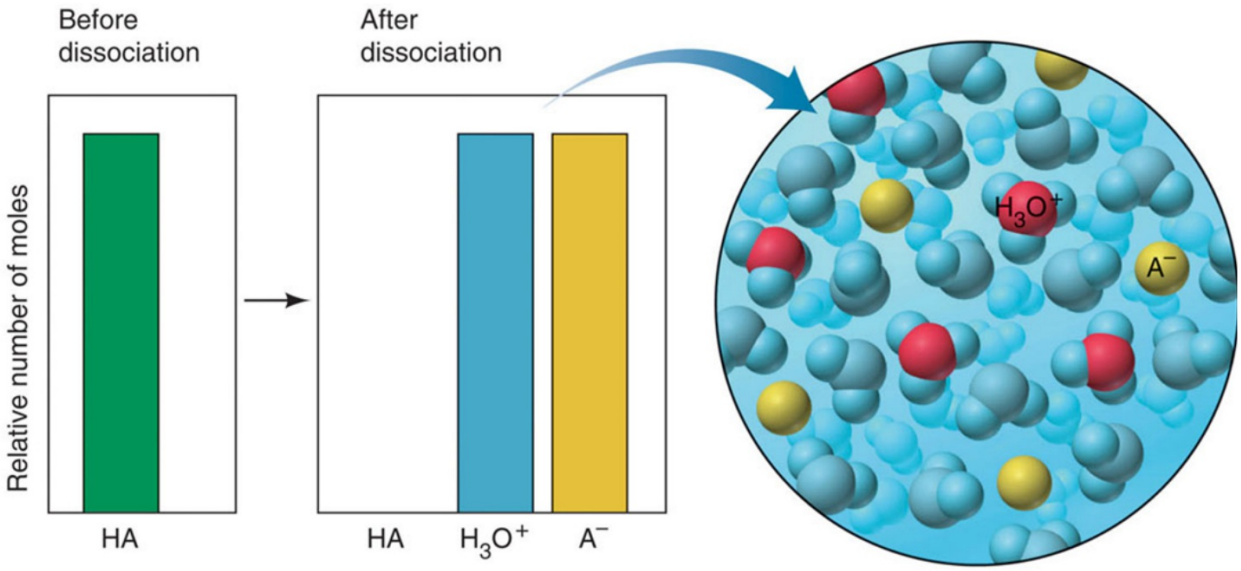
Derivation of the Strength of Oxoacids



Deals with electron withdrawing and electronegativity

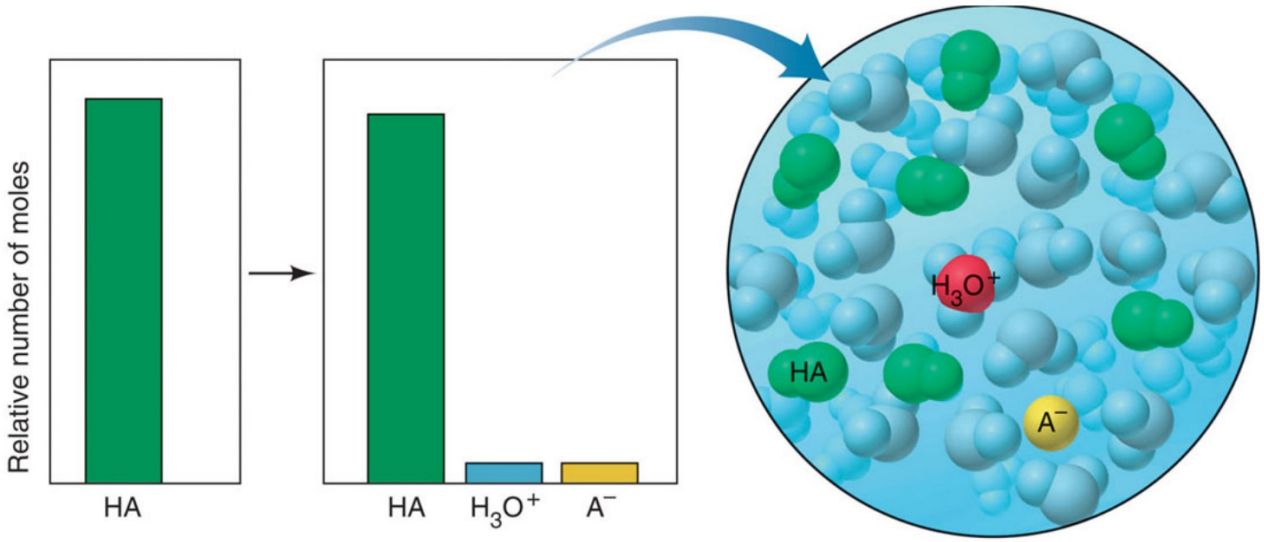

Electronegativity increases,
acidity increases
Bond strength decreases,
acidity increases
6A(16)
7A(17)
H2O
HF
H2S
HCl
H2Se
HBr
H2Te
HI

The Extent of Dissocation for Strong Acids



Strong acid: $HA(g \text{ or } l) + H_2O(l) \longrightarrow H_2O^+(aq) + A^-(aq)$

The Extent of Dissocation for Weak Acids



Weak acid: $HA(aq) + H_2O(l) \rightleftharpoons H_2O^+(aq) + A^-(aq)$

Acid Strength (K_a) and the Meaning of K

$$HNO_{3(aq)} + H_2O_{(l)} \rightarrow H_3O^+_{(aq)} + NO_3^-{}_{(aq)}$$

$$HCN_{(aq)} + H_2O_{(l)} \leftrightarrow H_3O^+_{(aq)} + CN^-_{(aq)}$$

derivation of K_a, strength / $[H_3O^+]$ / K_a relationship

General Characteristics of Acid-Base Solution Equilibrium

The acidity of a solution is based on the relationship between the $[H_3O^+]$ and the $[OH^-]$. When:

$[H_3O^+]$	$[OH^-]$	acidic
$[H_3O^+]$	$[OH^-]$	neutral
$[H_3O^+]$	$[OH^-]$	basic

What is K_w?

Final point: Rxns proceed in the direction of

SA + SB ➔ WA + WB

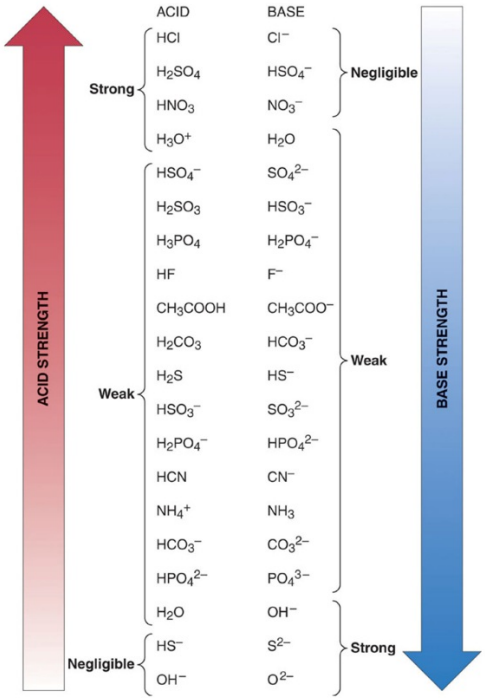
(stronger) (weaker)

Example: Extent of a Reaction

Consider the following system:

hydrofluoric acid is mixed with water

What is the extent of the reaction? (i.e. Which side of the reaction will be favored, products or reactants?)



Practice

Consider these systems in equilbrium, individually:

(a) the dihydrogen phosphate ion is mixed with aqueous ammonia

(b) the bisulfide ion is mixed with water

For each system, what is the extent of the reaction?