Chp. 14 Acids/Bases

Characteristics:

Acids	Bases
re / litmus acid	
pH < 7	pH > 7
sour taste – citrus fruit	bitter taste (soap, baking soda)
corrosive	corrosive
caustic – burns	caustic
electrolyte – strong	electrolyte
formed from acid anhydride + H_2O	formed from basic anhydride + H_2O
↑ nonmetallic oxide: SO_2, CO_2	metallic oxide: MgO, CaO

$CO_2 + H_2O \rightarrow H_2CO_3$

Acid/Base Theories: 3 of these

1. **Arrhenius**
   Acids produce [H^+] in solution
   Bases produce [OH^-] in solution

   Limiting--must have solutions and bases must be hydroxides

NH$_3$ - base - not a hydroxide cmpd

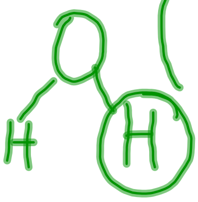
2. **Bronsted-Lowry**
   Acid is proton (H^+) donor
   Base is proton acceptor

   Broader—can include gases

3. **Lewis**
   Acid accepts lone electron pair.
   Base donates lone electron pair.

   Broadest of the 3

$H_2O + H_2O \rightarrow H_3O^+ + OH^-$



general equation for dissolution of acid:

hydronium ion

$HA\ (aq) + H_2O\ (l) \rightarrow H_3O^+\ (aq) + A^-\ (aq)$

(acid) (base) (c. acid) (c. base)

Conjugate acid—substance formed when a base gains a proton (base + H^+)

Conjugate base—ion that's left after the acid has donated a proton (acid leftovers)

Note: water can act as a base because of the lone prs. of electrons on the oxygen atom.

Ex. $HCl\ (aq) + H_2O\ (l) \rightarrow H_3O^+ + Cl^-$

acid base c. acid c. base

$NH_3\ (aq) + H_2O\ (l) \rightarrow NH_4^+ + OH^-$

base acid c. acid c. base

amphoteric subst -

has properties of acids and bases

ex H_2O

Practice:

1. Give the conjugate base for each of the following Bronsted-Lowry acids:
   - a. $HClO_2$ — ClO_2^-
   - b. H_2S — HS^-
   - c. HSO_4^- — SO_4^{2-}
   - d. NH_4^+ — NH_3

what's left of acid

2. Give the conjugate acid for the following Bronsted-Lowry bases:
   - a. IO^- — HIO
   - b. CH_3COO^- — CH_3COOH
   - c. $HAsO_4^-$ — H_2AsO_4
   - d. NH_3 — NH_4^+

add proton

3. For each of the following equations label the Bronsted-Lowry acid, Bronsted-Lowry base, conjugate acid and conjugate base.

a. $NH_4^+ (aq) + CN^- (aq) \leftrightarrows HCN (aq) + NH_3 (aq)$

acid, base, c. acid, c. base

b. $(CH_3)_3 N (aq) + H_2O (l) \leftrightarrows (CH_3)_3NH^+ (aq) + OH^- (aq)$

base, acid, c. acid, c. base

c. $HCHO_2 (aq) + PO_4^{3-} (aq) \leftrightarrows CHO_2^- (aq) + HPO_4^{2-} (aq)$

acid, base, c. base, c. acid

d. $HSO_4^- (aq) + CO_3^{2-} (aq) \leftrightarrows SO_4^{2-} (aq) + HCO_3^- (aq)$

acid, base, c. base, c. acid

e. $H_3O^+ (aq) + HPO_4^{2-} (aq) \leftrightarrows H_2PO_4^- (aq) + H_2O (l)$

acid, base, c. acid, c. base

Acid dissociation constant (K_a):

Equilibrium expression for a general acid dissolved in water reaction

$$K_a = \frac{[H_3O^+]\,[A^-]}{[HA]}$$

Water is not included because in dilute soln. the conc. of water is high and changes so little it is assumed to be constant.

If H_2O is a stronger base than A^- (water is more attracted to the H^+ than the A^-) the equilibrium position will lie to the far right (products favored) because most of the acid has dissolved (ionized). K has a large value.

If the A^- is a stronger base than the water the equilibrium position will lie to the far left (reactants favored). Most of the acid (HA) will be present in the equilibrium mixture (acid has partially ionized). K has a small value.

~~Do the examples on p. 656 (black book p. 639-40).~~

Strong acid:

- Almost all is ionized at equilibrium
- Has weak conjugate base (one that's not attracted to a p^+ and is weaker than water)
- Equilibrium lies to the right
- ex. H_2SO_4, HCl, $HClO_4$, HNO_3, HBr

Weak Acid:

Most of original acid is still present at equilibrium – dissociates a little

Has strong conjugate base (conjugate base is more attracted to proton than water)

Equilibrium lies to left

Ex. H_3PO_4, HNO_2, HClO

Most acids are oxyacids—have acidic H^+ attached to oxygen atom

Organic acids contain C backbone and a carboxyl group

equilibrium lies to left

are weak acids

ex. CH_3COOH, C_6H_5COOH

Arrange the following bases in order of increasing strength: (remember H_2O is stronger base than the conjugate base of a strong acid but weaker than the conjugate base of a weak acid)

H_2O, F^-, Cl^-, NO_2^-, CN^-

Water is amphoteric. It can behave as an acid or a base. It autoionizes—transfers proton from water molecule to another to produce a hydroxide ion and a hydronium ion.

$$2\ H_2O\ (l) \leftrightarrows H_3O^+\ (aq) + OH^-\ (aq)$$

NH_3 is also amphoteric.