Lecture Notes O: Acid-Base Chemistry II

1) *Bronsted-Lowry definition of an acid and a base:*

Acid: proton donor
Base: proton acceptor

Examples of Bronsted acids and bases:

$HAc + H_2O \rightleftharpoons H_3O^+ + Ac^-$ ($HAc = CH_3COOH$, $Ac^- = CH_3COO^-$)

$H_2S + H_2O \rightleftharpoons H_3O^+ + HS^-$

$HS^- + H_2O \rightleftharpoons H_3O^+ + S^=$

$NH_3 + H_2O \rightleftharpoons OH^- + NH_4^+$

$Ac^- + H_2O \rightleftharpoons OH^- + HAc$

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

2) Weak acids and bases

Hydrofluoric acid	HF +	H_2O	$\rightleftharpoons$	$H_3O^+ + F^-$	$K_a = 6.6\times10^{-4}$	pKa = 3.18
Formic acid	HCOOH +	H_2O	$\rightleftharpoons$	$H_3O^+ + HCOO^-$	$K_a = 1.77\times10^{-4}$	pKa = 3.75
Acetic acid	HAc +	H_2O	$\rightleftharpoons$	$H_3O^+ + Ac^-$	$K_a = 1.76\times10^{-5}$	pKa = 4.75
Nitrous acid	HNO_2+	H_2O	$\rightleftharpoons$	$H_3O^+ + NO_2^-$	$K_a = 4.6\times10^{-4}$	pKa = 3.34
Acetyl Salicylic acid	$C_9H_8O_4$ +	H_2O	$\rightleftharpoons$	$H_3O^+ + C_9H_7O_4^-$	$K_a = 3\times10^{-4}$	pKa = 3.52
Hydrocyanic acid	HCN +	H_2O	$\rightleftharpoons$	$H_3O^+ + CN^-$	$K_a = 6.17\times10^{-10}$	pKa = 9.21
Ammonia	NH_3 +	H_2O	$\rightleftharpoons$	$NH_4^+ + OH^-$	$K_b=1.79\times10^{-5}$	$pK_b = 4.74$
	$C_2H_5NH_2$ +	H_2O	$\rightleftharpoons$	$C_2H_5NH_3^+ + OH^-$	$K_b=5.6\times10^{-4}$	$pK_b = 3.25$

Problem

What is the pH of a 1M solution of acetic acid?

3) Hydrolysis

What is the pH of a 1M solution of Sodium Acetate?

Concept

Consider an exceptionally weak acid, HA, with a $K_a = 1x10^{-20}$. You make a 0.1M solution of the salt NaA. What is the pH?

a) 1 b) 2 c) 12 d) 13

4) Various acid-base reactions

Acid dissociation

$HAc + H_2O \leftrightarrow H_3O^+ + Ac^-$ $K_a = 1.76x10^{-5}$ ($pK_a = 4.75$)

Hydrolysis

$Ac^- + H_2O \leftrightarrow OH^- + HAc$ $K_b = K_w/K_a = 5.68x10^{-10}$.

Reverse of the above:

$Ac^- + H_3O^+ \leftrightarrow HAc + H_2O$ $1/K_a = 5.68x10^4$

$HAc + OH^- \leftrightarrow Ac^- + H_2O$ $1/K_b = 1.76x10^9$