Friday, May 17, 2019

Answers to yesterday's homework:

BRØNSTED - LOWRY ACIDS & BASES WORKSHEET

Label the Brønsted-Lowry acids (A), bases (B), conju
following reactions.

EXAMPLE: $H_2O + Cl^- \leftrightarrow OH^- + HCl$
(A, B, CB, CA)

1. $C_6H_5NH_2 + H_2O \leftrightarrow C_6H_5NH_3^+ + OH^-$ (B, A, CA, CB)
2. $H_2SO_4 + OH^- \leftrightarrow HSO_4^- + H_2O$ (A, B, CB, CA)
3. $HSO_4^- + H_2O \leftrightarrow SO_4^{-2} + H_3O^+$ (A, B, CB, CA)
4. $HBr + OH^- \leftrightarrow H_2O + Br^-$ (A, B, CA, CB)
5. $NH_3 + H_2O \leftrightarrow NH_4^+ + OH^-$ (B, A, CA, CB)

CONJUGATE ACID-BASE PAIRS WORKSHEET

ACID	BASE
H_2SO_4	HSO_4^-
H_3PO_4	$H_2PO_4^{-1}$
HF	F^-
HNO_3	NO_3^-
$H_2PO_4^-$	HPO_4^{-2}
H_2O	HO^{-1} OH^{-1}

ACID	BASE
HSO_4^-	SO_4^{-2}
HPO_4^{-2}	PO_4^{-3}
NH_4^+	NH_3
H_3O^+	H_2O
HNO_2	NO_2^-
NH_3	NH_2^-

$$\frac{H_3PO_4^{\,0} \quad - H^{-(1)}}{H_2PO_4^{-1}} \qquad \frac{F^{-1} \quad + H^{+1}}{HF}$$

New material started yesterday:

STRENGTH RULE OF ACIDS & BASES (B-L theory):

**The stronger a base is, the weaker its conjugate acid.

**The weaker a base is, the Stronger its conjugate acid.

**The stronger an acid is, the weaker its conjugate base.

Which is a weaker base, Cl^- or NO_2^-?

stronger CA HCl (strong) HNO_2 (weak)

Which is a stronger base, HSO_4^- or $H_2PO_4^-$?

weaker CA H_2SO_4 (strong) H_3PO_4 (weak)

New Material: (bonus question on Tuesday's quiz)

Acid Dissociation Constant (K_a) NOTES

nA + mB <---> eC + fD (general equilibrium rxn.)

Reminder #1 $K_{eq} = \frac{[C]^e [D]^f}{[A]^n [B]^m}$

Reminder #2 A weak acid does not completely dissociate (break into pos. & neg. ions); some remain together as molecules; "dissociation equation" for weak acids uses <--->

Example of a dissociation equation for a weak acid, HNO_2:

$$HCl \rightarrow H^+ + Cl^-$$ strong acid

$$HNO_2 \rightleftharpoons H^+ + NO_2^-$$ weak acid

$$K_{eq} = \frac{[H^+][NO_2^-]}{[HNO_2]}$$

$$pH = -\log[H^+]$$

$$K_a = \frac{[H^+][NO_2^-]}{[HNO_2]}$$

EXAMPLE PROBLEM:

Nicotinic acid, $HC_2H_4NO_2$, is a B vitamin. It is also a weak acid with $K_a = 1.4 \times 10^{-5}$. What are the $[H^{+1}]$ and pH of a 0.010 M solution of $HC_2H_4NO_2$?

To solve...

1.) Write a dissociation equation for the weak acid. $HC_2H_4NO_2 \text{ <---> } H^{+1} + C_2H_4NO_2^{-1}$

2.) Write a Ka expression for the reaction in step 1. $K_a = \frac{[H^{+1}]\,[C_2H_4NO_2^{-1}]}{[HC_2H_4NO_2]}$

3.) (All of the weak acids we will study are monoprotic. That means that the acid will only lose 1 H. This means that the mole ratio between H^{+1} and the neg. ion in the equilibrium reaction will be 1:1.

Substituting in the values from the problem...

$$1.4 \times 10^{-5} = \frac{[x]\,[x]}{0.010^*} \qquad 1.4 \times 10^{-7} = x^2$$

$$x = 3.74 \times 10^{-4}\ M = [H^{+1}]$$

* We assume that $[HC_2H_4NO_2] = 0.010$ M because only a small amount dissociates. When the amount that actually dissociates is subtracted from the original concentration, the difference will be negligible.

Example 2:

A student prepared a 0.10 M solution of formic acid, $HCHO_2$ (monoprotic), and measured its pH at 25°C to be 2.38. Calculate the K_a for formic acid at this temperature.

$$HCHO_2 \rightleftharpoons H^+ + CHO_2^-$$

$$Ka = \frac{[H^{+1}][CHO_2^-]}{[HCHO_2]}$$

$$[H^+] = 10^{-pH}$$

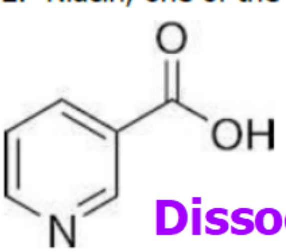
$$[H^{+1}] = 0.00417\ M$$

$$Ka = \frac{0.00417 \cdot 0.00417}{0.10}$$

$$Ka = 1.7 \times 10^{-4}$$

Practice on your own:

2. Niacin, one of the B vitamins, has the following molecular structure: (When writing the dissociation equation for niacin, use "H-Nia" as the formula for niacin.)



A 0.020 M solution of niacin has a pH of 3.26. What is the acid dissociation constant, K_a, for the ionizable proton?

Dissociation equation: H-Nia <---> H^{+1} + Nia^{-1}

$$Ka = \frac{[H^+][Nia^-]}{[H\text{-}Nia]}$$

$$[H^{+1}] = 10^{-3.26}$$

$$[H^{+1}] = 5.5 \times 10^{-4}$$

$$1.5 \times 10^{-5} = \frac{(5.5 \times 10^{-4})^2}{0.020}$$