

1. K_a/K_b Calculations

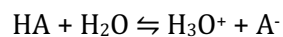
Complete the following statements:

- As a solution becomes more acidic...
 - $[H_3O^+]$ increases or decreases?
 - pH increases or decreases?
 - $[OH^-]$ increases or decreases?
 - pOH increases or decreases?
- If the pH of a solution equals 5.00, the $[OH^-]$ equals _____ M.
- If the pOH of a solution decreases by 5, then the $[H_3O^+]$ has _____ (increased or decreased) by a factor of _____.

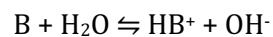
Calculations Involving K_a and K_b

Recall...

Acid = HA and Base = B



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



$$K_b = \frac{[HB^+][OH^-]}{[B]}$$

Write the chemical equation and K_a expression that represents the reaction of HNO_2 in water.

Write the chemical equation and K_b expression that represents the reaction of NH_3 in water.

CALCULATIONS FOR WEAK ACIDS

Problem Type 1: Calculating pH

Example: Calculate the pH and pOH of 0.50 M solution of hydrofluoric acid.

- Is HF a strong or weak acid?
- What is the chemical equation? (What kind of arrow will you use?)
- What is the K_a value (from the table!) and expression?
- Since this is a weak acid, equilibrium is established. ICE TABLE!!

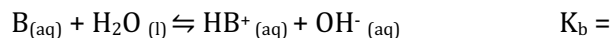
	HF _(aq)	+	H ₂ O _(l)	⇌	F ⁻ _(aq)	+	H ₃ O ⁺ _(aq)
Initial							
Change							
Equilibrium							

We don't include the concentration of water because we assume the $[H_2O]$ remains constant.

- Fill out values for the K_a expression.
- The expression in the denominator: $0.50\text{ M} - x$ can be assumed to be $\cong 0.50\text{M}$.
 - The value of K_a is very small compared to the initial concentration of the acid. This means that the percent of the acid that actually ionizes will not significantly change the original concentration.
 - **If initial $[HA]$ is at least 10^3 times larger than the K_a value, the assumption is valid.**
- Solve for unknown.

CALCULATIONS FOR WEAK BASES

As with acids, most bases are weak. Using the symbol "B" for a weak base, we can represent the equilibria of weak bases in water:



We must calculate the K_b for that base by using the K_a value of its conjugate acid

Consider the conjugate acid/base pair of NH_4^+ and NH_3 and their respective K_a and K_b expressions:

NH_4^+	NH_3
Reaction:	Reaction:
$K_a =$	$K_b =$

Two common terms appear in each equation.

- Multiply the two expressions together and cancel the common terms...

$$K_a \times K_b =$$

This allows us to formulate the following relationship for conjugate acid-base pairs:

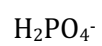
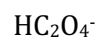
$$K_a \text{ (conjugate acid)} \times K_b \text{ (conjugate base)} = K_w = 1.0 \times 10^{-14}$$

For the following weak bases, write out the equation with water and calculate the K_b .

CN^-

NO_2^-

The following species are amphoteric. Compare K_a and K_b .



Problem Type 1: Calculating pOH

Practice: Calculate the pH and pOH of a 0.50 M solution of HSO_3^- .

Practice: Calculate the pH of a solution containing 0.20 M CN^- .

Problem Type 2: Calculating initial [B]

Practice: What concentration of NH_3 would be required to produce a solution with $\text{pH} = 10.50$?

Problem Type 3: Calculating K_b

Practice: A solution is prepared by dissolving 9.90 g of the weak base hydroxylamine, NH_2OH in enough water to produce 500.0 mL of solution. The pH of the solution is found to be 9.904. Calculate the K_b for hydroxylamine.

Practice: A 0.400 M solution of the weak base methylamine, CH_3NH_2 , is found to have a pH of 13.30. Calculate the K_b and $\text{p}K_b$ of methylamine.

Hebden Workbook: Pg. 153-4 #84-93

