Review

A. $K_a$ value is directly related to acid strength (the ability to donate $H^+$)
B. Weak acid vs. strong acid ($K_a$'s and % dissociation).
C. Conjugate acid-base pairs only differ by a proton.
D. $K_a \times K_b = K_W$ for conjugate acid-base pairs.
E. $K_b$ value is directly related to base strength (the ability to accept $H^+$)
F. Know how to write out $K_a$ and $K_b$ expressions.
G. The weaker the acid, the stronger the conjugate base (and vise versa).

<table>
<thead>
<tr>
<th>Acid</th>
<th>$K_a$</th>
<th>Relative Acid Strength</th>
<th>Conjugate Base</th>
<th>$K_b$</th>
<th>Relative Base Strength</th>
</tr>
</thead>
<tbody>
<tr>
<td>HCl</td>
<td>$10^6$</td>
<td></td>
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<tr>
<td>HF</td>
<td>$7.2 \times 10^{-4}$</td>
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<tr>
<td>HC$_2$H$_3$O$_2$</td>
<td>$1.8 \times 10^{-5}$</td>
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<tr>
<td>HOCl</td>
<td>$3.5 \times 10^{-8}$</td>
<td></td>
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<tr>
<td>NH$_4^+$</td>
<td>$5.6 \times 10^{-10}$</td>
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</tbody>
</table>

Common Misconceptions

- Some think that the statement “the weaker the acid, the stronger the conjugate base”, implies that the conjugate base of a weak acid is strong. THIS IS WRONG!
- The conjugate base of a weak acid is always a weak base.
- Similarly the conjugate acids of weak bases are not strong acids but weak acids.
- Some believe that the conjugate base of a strong acid is a weak base.
- Actually, conjugate bases of strong acids are **worthless bases**.
- Notice the $K_b$ value for Cl$^-$, it is a worse base than H$_2$O.
- We will assume that conjugate bases of strong acids have no basic properties whatsoever ($K_b \ll K_W$).
- Other conjugate bases of strong acids: NO$_3^-$, Cl$^-$, I$^-$, Br$^-$, ClO$_4^-$, HSO$_4^-$. Any time you see these ions in solution they can be ignored as bases.
- HSO$_4^-$ acts as a weak acid but has no basic properties.
Similarly Na⁺, K⁺, Ca²⁺, Sr²⁺ and other alkali metal and alkaline earth metal ions have no acidic or basic properties.

Review Question:

1. Which solution will be basic and which will be neutral, 1.0 M NaCl and 1.0 M NaF?

2. \[
    \text{HA (aq)} + \text{H}_2\text{O (l)} \rightleftharpoons \text{H}_3\text{O}^+ \text{(aq)} + \text{A}^- \text{(aq)}
\]
   (a) If water is a better base than A⁻, which way will the equilibrium lie?
   (b) If water is a better base than A⁻, does this mean that HA is a strong or a weak acid?
   (c) If water is a better base than A⁻, is the value for Kₐ greater or less than 1?

Behaviour of strong acids in water

- In the case of a strong acid in water, we assume the strong acid is completely dissociated in water because the Kₐ values for strong acids are much greater than one.
- You must memorize all of the strong acids.
- Since we assume strong acids are 100% dissociated in water, the we always say the major species present in a strong acid solution are H⁺ and the conjugate base of the strong acid.
- We ignore the amount of H⁺ donated by water because the Kₐ for strong acids is so large it will be the dominant product of H⁺ in solution.
- Since K_W is very small the amount of H⁺ produced from this reaction will be small.
- In general the equation with the largest K value will be the dominant reaction.
- Negative pH values are possible.
- Calculating the pH of H₂SO₄ solutions are a little complicated because it is a polyprotic acid, we will discuss this situation in an upcoming class.
Examples:

Chapter 14 #47

What are the major species present in 0.250 M solutions of each of the following acids? Calculate the pH of these solutions:

(a) HClO₄
(b) HNO₃

Chapter 14 #48

Calculate the pH of each of the following solutions of a strong acid in water:

(a) 0.10 M HCl
(b) 5.0 M HCl
(c) 1.0 x 10⁻¹¹ M HCl

Calculating the pH of strong bases

- Just like strong acids, strong bases are completely ionized.
- Strong bases to memorize: LiOH, NaOH, KOH, RbOH, CsOH, Ca(OH)₂, Sr(OH)₂ and Ba(OH)₂.

Examples:

Calculate the pH and pOH of the following:

(a) 0.010 M KOH
(b) 0.010 M Sr(OH)₂
- pH can be less than 0 (10 M HCl, pH = -1.0) or greater than 14 (10 M NaOH, pH = 15.0).
- The only defining number on the pH scale is 7.0.
- pH = 7.0 is neutral
- pH < 7.0
- pH > 7.0

**Example:** Chapter 14 #82

Calculate the concentration of an aqueous Sr(OH)$_2$ that has a pH = 10.50.

**Answer:**